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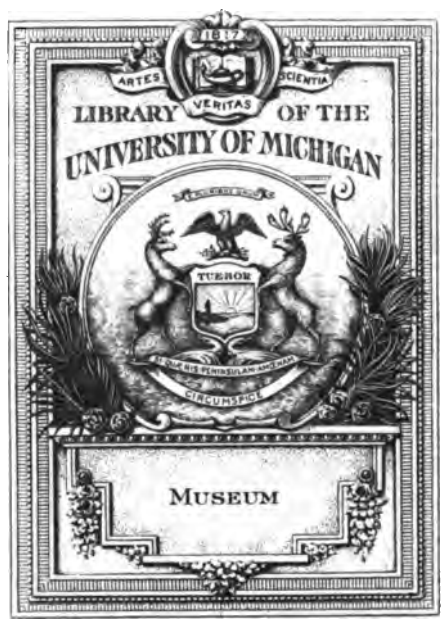
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Certain Mounds and Village Sites in Ohio

Vol. 3 Part 3

Flint Ridge

By WILLIAM C. MILLS, M. Sc.

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FLINT RIDGE.

BY WILLIAM C. MILLS.

INTRODUCTORY NOTE.

The explorations and studies recorded in this paper on Flint Ridge were undertaken for the purpose of securing for exhibition in the State Museum a complete collection of the various kinds of flint found at Flint Ridge as well as the implements used in quarrying the flint from its natural bed. A preliminary examination of Flint Ridge beginning at its western edge in Hopewell Township, Licking County, Ohio, extending eastward and ending in western Muskingum County, a distance of practically eight miles, made it apparent that a more extended and systematic study of the quarrying, manufacture, and distribution of flint objects was necessary to enable one to cope with the many complex problems arising from a study of the art of shaping the raw material into artificial forms to meet the varied needs of a primitive people.

As the search for specimens of flint and the implements used in quarrying progressed, it was found necessary to examine a number of so-called pits, in search of the evidence of quarrying flint and to find the flint in its original bed, partly quarried, and this proved a very difficult task in the region of the suitable flint for making knives, arrow, and spear points, for this flint had practically all been removed from its original bed, carried to workshops and made into suitable forms convenient for transportation.

The examination soon developed the fact that primitive man may have developed quarrymen who devoted their time exclusively to producing the raw material and turning over such material to a second industry, that of roughing-out the blank forms. This, however, may have been accomplished by the same individual but at different times and places.

The third process comprised the art of trimming, making into special forms and finishing blades or cores ready for transportation.

Therefore, it seems that the three well defined steps would give rise to three separate industries carried on by the same individuals at different times or places or by different groups of experts trained in their respective industry. The Flint Ridge quarries for the most part show that the first and second steps were accomplished mainly at the quarries, because primitive man found it uneconomical to transport blocks of material of which nine-tenths would be thrown away as useless; and further, the promising blocked-out piece might develop seams or geodes of crystals that would destroy its usefulness in making the desired implement. The workshop developed many such specimens, showing the advisability of working out the form of the article to be shaped in such a manner as to test the material and its capacity for specialization before leaving the source of supply. In other words, Flint Ridge became a great factory site, in which two principal commodities were manufactured and made ready to transport by manpower over the entire state of Ohio and into other states where the raw material was lacking. The two commodities mentioned were the flint blades, ranging in size from

the small arrowhead to the blades for making into spears, and the flint core, from which the flint knife was made. The flint used for these purposes was found in the region of the cross-roads directly north of Brownsville. The workshops in close proximity to the quarries contained many rejects, showing that even with expert selection many of the pieces were not adapted for making the desired flint knife with a long, keen cutting edge, so highly prized by primitive man.

As the examination of the quarries and the region surrounding them progressed, many problems arose concerning the probable prehistory Indians who did the extensive quarrying. All the surrounding workshop sites were examined but no implements other than those used in shaping the blades were found. However, at the west end of the ridge was located a large mound surrounded by a circle made of blocks of flint and earth. This mound was examined and the culture determined to be the Hopewell, the highest in point of advanced prehistory civilization in Ohio, showing that this culture had established themselves at the site of this wonderful supply of the most desirable raw material used in the manufacture of artificial forms to meet the varied needs of the primitive inhabitants. A detailed account of the examination of this mound will be found in the pages following the account of the examination of the quarry sites.

I am greatly indebted to many individuals for their assistance in the examination of Flint Ridge and especially to Mr. H. C. Shetrone, assistant curator, who carried forward the work on occasions when other duties connected with the Museum compelled me to be

absent; to Dr. Clark Wissler of the American Museum of Natural History, New York, who spent a short time in July, 1918, and again in August, 1919, for his help and counsel; to Professor J. Arthur MacLean of the Cleveland Museum of Art, for his assistance in the exploration of the mound located at the west end of the "Ridge;" to Mr. Jay Clark, a resident of the "Ridge" for more than forty years, for help and information given and specimens presented to the museum. To the many residents of the "Ridge" I wish to extend my thanks for assistance in the laborious excavations made in various sections and for specimens presented to the museum.

THE FIELD OF INVESTIGATION.

Flint Ridge is a very irregular plateau-capped line of rugged hills, located in Licking and Muskingum counties, about midway between Newark, the county seat of Licking, and Zanesville, the county seat of Muskingum. The region is a part of the great Allegheny Plateau which has an elevation of approximately 1,200 feet at the western end of the ridge in Licking, gradually decreasing eastward, probably due to the greater eroding agencies. The Licking River, located about five miles north of Flint Ridge, runs approximately east and parallel with Flint Ridge and empties into the Muskingum River. The small ribbon-like valley plains, with small streams fed by springs from the "Ridge", would furnish no means of water transportation to and from the source of supply; consequently the only way to reach the "Ridge" was by trails through the deep tangled forest, leading to the great manufacturing industrial center of the prehistoric Indian, in the region of Clark's blacksmith-shop, located at the road-crossing three miles directly north of Brownsville. It is striking to observe that the varied phenomena studied are assembled within a radius of one mile of this place, and at the extreme eastern end of the "Ridge". The flint occurring outside of these two places was of no practical use to primitive man, be-

FIG. 1. Cleared portion of Flint Ridge looking north from east and west road on the top of the Ridge.

cause of its unfitness for chipping into form on account of impurities.

In the region of the cross-roads the best examples of flint may be found, as well as the largest quarries located on the "Ridge".

An examination of the quarries developed the fact that only a very small portion of the flint deposit was of use to prehistoric man in the manufacture of artifacts, as much of the flint was full of seams and cracks which did not permit of the manufacture of a desired artifact with any degree of certainty, as demonstrated by the many broken blades found on the site of the work shop.

Another feature of the flint in this section was the presence of countless geodes filled with quartz crystals. The geodes varied in size from that of a pea or less to large geodes of from twelve to fourteen inches in diameter. The quartz crystals found in the geodes were usually small, but the large geodes generally contained large crystals. Apparently the crystals, unless very large, were not used in any way and were thrown away with the useless flint.

The flint found outside of the regions where it was quarried is very porous and fossiliferous, and very frequently mixed with calcareous or argillaceous material, which rendered it useless to primitive man as far as chipped implements were concerned.

The flint at the west end of the "Ridge", in Licking County, was especially useless to primitive man, but the early white settler found it well adapted to the making of buhr-stones, used in grinding grain into flour. Near the western edge of the outcrop of the flint, several partly formed buhr-stones, each weighing a ton or more, may be seen where they were quarried, upon the farm of Mr. William Hazlett, near the only large mound located upon the "Ridge".

The flint at the eastern end of the "Ridge" is likewise unfit for implement making but well adapted for buhr-stones. In the early pioneer days of Ohio, Mr. Samuel Drumm quarried the flint in suitable blocks and fashioned them into small hand buhr-stones. One of the buhr-stones complete and one partly shaped

FIG. 2. View looking north from the point of the Ridge directly north of Clark's Blacksmith shop.

and found at the quarry where many more were in evidence are shown in Fig. 3.

The farm upon which the quarry is located is owned by Mr. George Fisher, who kindly presented to the museum a fine sample of the partly shaped buhr-stone shown to the right in Fig. 3 as well as a buhr-stone sent from France and used as a sample stone.

The manufacture of these small buhr-stones during the early settlement of the country was a very great convenience to the people, as water mills for grinding grain could only be constructed where proper conditions prevailed, and often long dis-

FIG. 3. Complete buhr-stone made by Mr. Samuel Drumm. To the left in Fig. 3 is a partly shaped buhr-stone from the farm of Mr. George Fisher.

tances would be traveled to find such a mill; consequently the small hand mill made from Flint Ridge flint was very desirable, and the manufacture of the buhr-stones proved to be a very lucrative industry. The buhr-stones manufactured at the Drumm site were sent to a point on the Old National Road, three miles to the south, where they were transported by ox teams as far west as the Mississippi River and as far east as Pittsburgh.

The preliminary examination of numerous quarries upon Flint Ridge made it apparent that the solution of the problem of quarrying the flint was unsolved and, to arrive at any definite conclusions, a systematic study of the entire area was necessary.

Consequently the field of investigation was extended to every part of the ridge where primitive man attempted to quarry and make use of the flint.

GEOLOGY OF FLINT RIDGE.

As a preliminary step to a study of the evidence of human industry on Flint Ridge, it is very important that the geology of the place be reviewed. Aboriginal flint quarries have long been known at Flint Ridge, but prior to 1830 little was known to the scientist concerning the geology of this region. The first writer referring to the aboriginal quarries was Caleb Atwater in his "Western Antiquities", page 28, as follows:

"A few miles below Newark, on the south side of the Licking, are some of the most extraordinary holes, dug in the earth, for number and depth, of any within my knowledge, which belonged to the people we are treating of. In popular language, they are called 'wells' but were not dug for the purpose of procuring water, either fresh or salt.

"There are at least a thousand of these 'wells'; many of them are now more than twenty feet in depth. A great deal of curiosity has been excited, as to the objects sought for by the people who dug these holes. One gentlemen nearly ruined himself by digging in and about these works, in quest of the precious metals; but he found nothing very precious. I have been at the pains to obtain specimens of all the minerals, in and near these wells. They have not all of them been put to proper tests; but I can say, that rock crystals, some of them very beautiful, and horn stone, suitable for arrow and spear heads, and a little lead, sulphur, and iron, was all that I could ascertain correctly to belong to the specimens in my possession. Rock crystals, and stone arrow and spear heads, were in great repute among them, if we are to judge from the numbers of them found in such of the mounds as were common cemeteries. To a rude people, nothing would stand a better chance of being esteemed, as an ornament, than such articles.

"On the whole, I am of the opinion, that these holes were dug for the purpose of procuring the articles above named; and that it is highly probable a vast population, once here, procured these, in their estimation, highly ornamental and useful articles. And it is possible that they might have procured some lead here, though by no means probable, because we no where find any lead which ever belonged to them, and it will not very soon, like iron, become an oxide, by rusting."

In 1836 the first geological survey of Ohio was published, in which Dr. Hildreth calls attention to the flint quarries in Ohio and comments on their great extent, beginning in Jackson County and extending north to Muskingum County, and calls the flint a calcareo-silicious formation.

Mr. J. S. Newberry, Chief Geologist of the Ohio Geological Survey, in discussing the carboniferous system in Ohio comments at some length concerning the famous Flint Ridge:*

"The origin of the silex in these flinty limestones has never been satisfactorily explained. It has sometimes been attributed to hot springs, of which the water contained much silica, but the general distribution of the flint and the immense number of fossils sometimes contained in it, seemed to me insurmountable objections to this view. It appears to me more probable that the silica was derived from microscopic organisms, such as the diatoms. It is well known that at the present time very extensive deposits of silicious earth ('infusorial earth') are being made in our lakes and lagoons. These are frequently associated with shell marl and sometimes bog iron ore. In the Tertiary age, even more extensive beds of diatomaceous silica were formed than any belonging to the present age yet discovered, the polishing slate of Bilin, ('tripoli'), Monterey, and Nevada 'infusorial earths,' etc. In the older formations no such strata are found, and yet it is hardly probable that the low forms of life from which these beds of silica are derived are of modern date. From some experiments recently made by Mr. Henry Newton at my request, we learn that the silicious shields of diatoms are more soluble than almost any other form of silica known, and it seems to me quite possible that in the older diatomaceous earths the individual forms have disappeared by solution, and the mass has been converted into compact amorphous silica, such as we find in our beds of chert. I would, therefore, suggest that in many parts of the lagoons which, from time to time, occupied the coal area, the shields of diatoms accumulated in beds of considerable thickness, and these, now blended and consolidated by solution, form our Coal Measure buhr-stones.

"In this view, the wide diffusion of the silica and its blending with and shading into purer limestone as though deposited in the quieter nooks of the broad lagoon, its association with fossils and iron, are all harmonious and confirmatory facts. If hot springs had furnished the silica, we should be pretty certain

*Geological Survey of Ohio, Vol. 2, page 142-143.

to find it impregnating other strata than the limestone, and should probably find some masses or accumulations heaped up about the source of supply, but we have discovered nothing of the kind; and the careful observation of the facts in the case has convinced me that the silica, like the lime, is indigenous and not exotic, that is, that it accumulated particle by particle as a sediment at the bottom of water where it was slowly drawn from solution and fixed by some vital agency."

In 1878, Mr. M. C. Read, Special Assistant of the Geological Survey of Ohio, wrote the Geology of Licking County, (Geological Survey of Ohio, Vol. 3,) and I quote from his report as follows:

"The number of this series found on the summit of most of the hills in the south-east part of the county is the flint, which is ordinarily regarded as on the horizon of Coal No. 6, the Great Vein of Perry and Hocking counties, this coal being represented by the thin and worthless seam underlying the flint. I am disposed, however, to regard the flint as the equivalent of the 'Black Marble,' so-called, of Coshocton county — which has beneath it a thin seam of coal, and is found in places only ten or twelve feet below Coal No. 6 — and the representative of the drab limestone of Columbiana county, often found directly beneath No. 6. In Coshocton county this 'Black Marble' often passes into a chert, as do all the limestones of that county, but none of them form so extensive and continuous deposits as the flint of Flint Ridge. Any one traversing this ridge for the first time would be surprised to find such a deposit on such a geological horizon. It simulates very accurately the broken-up debris of a vertical dike, the fragments often covered with perfect crystals of quartz, the rock itself being highly crystalline and often translucent. It is something of a puzzle to understand how such a deposit is found in a series of undisturbed and unmodified sedimentary rocks. The adjacent surfaces of two blocks of the chert are often found covered with quartz crystals of considerable size, as thoroughly interlocking with each other as if one were a cast, and the other the matrix. I cannot imagine conditions which would spread such a deposit over the floor of a sea or any other body of water. A substitution of silicious matter deposited from solution, in the place of a soluble limestone previously deposited, is the only plausible explanation. This substitution has taken place over large areas in this part of the State, and has left these silicious deposits only upon the horizons of the different limestones."

Mr. Read inserts as a foot-note the following:

"The question of the origin of the silica, which so often replaces the carbonate of lime in the Coal Measure limestones, is discussed at some length in Vol. 2 of this report, and it is there attributed to DIATOMS. These microscopic plants, as is well known, bear silicious frustules, which accumulate at the bottom of some lakes and ponds till they form beds many miles in extent and several feet in thickness. They probably inhabited portions of the shallow land-locked basins where the limestones were formed in such numbers as to supply silica for concretions or cherty layers, and sometimes to replace the calcareous bed entirely, just as we find the diatomaceous earths locally replacing shell-marl in the bottoms of our lakes and marshes. The silica which forms the frustules of the diatoms has been proved by experiment to be unusually soluble, and in the flint beds, the individual forms have doubtless been either so completely dissolved or so enveloped in soluble silica as to be lost. The quartz crystals referred to by Mr. Read as coating the blocks and filling the crevices and cavities of the flint, are evidently of modern origin, and have been formed by a deposit of silica, from solution, in whatever receptacles were open to it."

Mr. Wilbur Stout in his Geology of Muskingum County, (Bulletin No. 21, Geological Survey of Ohio), assigns the Flint Ridge flint to the horizon of the ferriferous limestone. I quote from Mr. Stout's report at length, as he covers the geological phenomena of Flint Ridge:

"In ascending order the important rock stratum above the Clarion coal is the Ferriferous or Vanport limestone, which is also often called Gray limestone owing to its color. This member is not persistent and is variable in character in the western part of Muskingum County where the bed is above cover. However, the scattered deposits of this member may be followed with some certainty from Perry County on the south into Coshocton County on the north. From Perry County it may be traced southward to the large and important field in Vinton, Jackson, Gallia, Scioto, and Lawrence counties, where it has characteristic development and excellent continuity. Owing to many wants in deposition and to rapid changes in character the bed is followed with more difficulty from Coshocton County northeastward to Mahoning and Columbiana counties where it again has good volume, and from where it has been directly traced into Lawrence and Beaver counties, Pennsylvania.

"Two well-defined phases of the Ferriferous member are present in Muskingum County. In most of the county the upper phase is a bed of rather pure flint or limestone, in many places several feet in thickness. The flint is best represented by the massive stratum that extends along Flint Ridge from Poverty Run in Hopewell Township, Muskingum County, to the Porter School in Franklin Township, Licking County. Dr. Orton assigned this rock to the horizon of the Ferriferous limestone.*

"Miss Clara Gould Mark also assigns the flint to this horizon. In 1916-17 the members of this Survey traced the stratum by stringers of flint and impure limestone to Bairds Furnace, Hocking County, where the member is a true limestone, definitely known to be correlative with the more massive and persistent Ferriferous beds of southern Ohio. Further, in its extension northward from Flint Ridge, Muskingum County, the stratum undergoes many changes, as it may be represented by thin local beds of flint, or by flint and limestone, or by limestone alone. Along the ridge known as the Highlands, in Cass Township, the horizon is marked locally by a thick bed of gray limestone very similar to that present in southern Ohio. North of this, along Graham Ridge, in Coshocton County, thin beds of flint again appear, and near Warsaw local deposits of impure limestone were observed. Similar conditions were noted in parts of Tuscarawas County. Although local, variable, and scattered, the deposits of this flinty phase in Muskingum County are sufficiently pronounced to be followed with certainty, and in the opinion of the writer they are correlative with the Ferriferous limestone of eastern and southern Ohio."

"The flint beds of the Ferriferous member in Hopewell and Franklin townships of Licking County are the largest in Ohio, and were extensively worked by the aborigines, who dug hundreds of pits along Flint Ridge in the mining of this material. The stratum was evidently worked for a long period, and the material, identified by its characteristic fossils, is widely distributed. Much of the flint chipped into arrows, knives, scrapers, etc., and found in the burial mounds and earthworks of the mound builders, as well as that similarly worked and found on the surface in this and adjoining states, is from Flint Ridge. The field is of exceptional interest both to the geologist and archæologist. The outcrop measurements indicate that the light-colored bed of flint is from 1 to 10 feet in thickness, and that it averages about 5 or 6 feet. This stratum is directly bedded on the shaly limestone, the thickness of which, from surface indications, is from 5 to 20 feet, or even more. Owing to

*Geol. Survey Ohio, Vol. V. p. 870.

the slumping of the flint and to the nature of the covering no good sections of the entire interval were obtained.

"Along the ridge at the head of Berry Run, in Hopewell Township, the light flint is massive, and varies from 3 to 10 feet in thickness. The bed was mined by the aborigines more extensively in this locality than on either the western or eastern part of the ridge. A section taken in a ravine east of the cross-roads follows:

		Ft.	*In.*
Flint, light	Ferriferous	5	..
Limestone, thin to medium bedded, shaly.	Ferriferous	7	..
Covered	Ferriferous	32	..
Sandstone, parts covered		32	..
Shale		1	..
Sandstone		23	..
Shale, calcareous, with shaly limestone.	Lower Mercer	1	..
Limestone, dark siliceous	Lower Mercer	..	8
Shales, calcareous, with shaly limestone.	Lower Mercer	5	..
Limestone, hard	Lower Mercer	3	6
Shale	Lower Mercer	..	2
Limestone, hard	Lower Mercer	1	8

"In this locality the light-colored flint or upper phase of the Ferriferous member is bedded on the shaly limestone or lower phase. No separation, except an irregular bedding plane, is evident, thus suggesting that both rocks were laid down during the same general deposition period. In the above section the interval between the Ferriferous member and the Lower Mercer limestone is about normal for the region."

ECONOMIC VALUE OF THE FERRIFEROUS LIMESTONE AND FLINT.

"The great value to the aborigines of the flint beds of the Ferriferous member in Muskingum County, and also in Licking County, is attested by the large quantities of earth and rocks mined in the excavation of the hundreds of pits scattered along Flint Ridge and along its spurs. This Flint was certainly held in high esteem by these ancient people, who used it in the manufacture of implements for domestic purposes, for hunting, and for war. Arrows, knives, skinners, scrapers, hoes, and drills made of flint from this locality, and recognized by the remains, are scattered over a wide area in the Ohio Valley and in the Lake Erie region. Their method of quarrying the flint and of shaping the implements is a subject of interest, but it belongs more to the province of archæology than to that of present-day geology and hence needs no further discussion here."

CHEMICAL ANALYSIS OF THE FLINT.

"The chemical as well as the physical properties of the light-colored flint on Flint Ridge are such that the material may be utilized for the manufacture of silica brick or for potter's flint of white ware bodies. The deposit along the main ridge for a distance of more than 5 miles was sampled by taking pieces thrown out of the pits excavated by the aborigines. This sample weighing more than 100 pounds was properly crushed and prepared for analysis. The chemical work was done by Prof. D. J. Demorest, who reports the following results:

Silicia, SiO_2	96.40
Alumina, Al_2O_3	1.52
Ferric oxide, Fe_2O_3	.48
Lime, CaO	.30
Magnesia, MgO	.04
Water, comb., H_2O	1.20
	99.94

CHARACTER AND ORIGIN OF THE FLINT.

I have given the view of Newberry as to the origin of the flint at Flint Ridge, which he attributes to diatomaceous plants, a view acquiesced in by Mr. Read, who wrote the Geology of Licking County, 1878. Mr. Stout gives three views as to the possible origin of the flint at Flint Ridge, and I quote from his report:

"The flint in the black layers is very solid and dense except for small cavities, which are irregularly spaced and frequently lined with transparent quartz crystals. The gray flint is also solid, and has a banded and somewhat mottled appearance, probably due to original deposition, and the analysis shows it to be anhydrous or nearly so. The coal formation flints seldom contain more than 2 per cent of water. Flint has a hardness comparable with that of quartz, and it breaks with a deep conchoidal fracture, the perfection of which depends on the texture of the material. This characteristic fracture is much more evident in the compact, vitreous varieties than in the more porous, grainy types which are mixtures of amorphous silica and quartz sand or calcareous or argillaceous material. It varies from nearly transparent to coal-black, and from the strikingly mottled or banded types to those traversed by small veins of different colored material of later formation.

"Three views are tenable as to the origin of the flints associated with the limestones or stratified on the horizons of these rocks:

"(a) That the flint was formed by direct precipitation of the siliceous matter by silica-secreting organisms.

"(b) That the flint was the resultant of chemical action of soluble silica and other components in the sea water upon the calcium carbonate of newly formed limestone. In this case the change took place while the limestone was forming or while it was yet under the direct influence of the salt brines.

"(c) That circulating ground waters, charged with siliceous and organic components which acted upon limestone deposited under normal conditions and buried by later sediments, slowly removed the calcium carbonate and deposited silica in its place. This action began as soon as the beds were covered by other material and is still effective. Under this condition the flint is entirely of secondary origin.

"In regard to the first view, it is necessary to account for large quantities of soluble silica and a means of precipitating it. The flint beds found in the coal formations of Muskingum County are directly associated with limestones, or more often occur on the horizons of these rocks. Judging from fossil and other evidence, these limestones are of organic origin and were laid down in shallow basins of the sea. The natural inference is, therefore, that the flint has a similar derivation. Some of the low forms of life, such as radiolaria, sponges, and diatoms, which inhabit both fresh and salt water, secrete silica. Such material secreted by an organism is hydrous and glassy and is readily dissolved by waters containing carbonates of the alkalis or alkaline earths. Carbon dioxide from a living or a decaying organism, however, readily precipitates this silica. It is also thrown down by hydrolysis in the presence of weak acids such as may occur from decaying organic matter. The rocks on these flint horizons show that a profusion of life existed in these early seas, a part of which was evidently silica-secreting, and the presence, or rather decay, of which would produce conditions often favorable for the direct deposition of silica.

"Some of the flint deposits in the coal formations of Muskingum, Perry, and Coshocton counties suggest such an origin. The material is very free from calcium and magnesium carbonates, has the mottling characteristic of gelatinous precipitates, and shows no distinct nuclei attending concretionary growths. Further, the relation of flint beds to limestone strata in some localities is also of interest. As noted in some of the preceding sections, a flint layer may lie either directly above or directly below a limestone which is very free from flinty material. Laterally the rocks often pass in a regular way from limestone or from sandstone to flint in about the same way as shale to sandstone

or carbonaceous shale to coal. Flint deposits are also nearly as abundant in the Pottsville and Allegheny formations of this area as limestone deposits. With varying conditions in these shallow seas where both siliceous and calcareous matter are being secreted, flint should result as one extreme and limestone as the other.

"The second view is closely related to the first, but it differs in that soluble silica replaces the calcium carbonate of newly formed sediments. As shown by several writers, the replacement of the calcium carbonate of shells, corals, etc., by silica is easily effected. The most favorable conditions would be where both silica and calcium carbonate are being secreted contemporaneously by organic life. Such silica is very soluble and the calcium carbonate is in a state which can be readily attacked, thus making replacement easy. The alkalinity and pressure of the water also aid in this work. The waters of these ancient seas contained a profusion of both plant and animal life, secreting either silica or calcium carbonate; they were warm, owing to the shallow depth and to the prevailing climate, and were partially saturated with mineral and organic components which aid in chemical action, all of which conditions favored replacement changes attending deposition.

"Such an origin appears plausible for some of the flint strata in the coal formations of this area. In a certain bed, as the Upper Mercer, for instance, flint may be overlain by limestone or limestone by flint, or the two may occur in almost any proportion. Substitutions are apparent, but it is difficult to determine whether they took place during the early period of formation or during a later period by the action of circulating waters. The deposits are intermediate stages between a limestone and a flint. The limestones on these horizons are everywhere fossiliferous and, as would be expected, the flints contain the same fossils, although they are less abundant and less delicatedly preserved, with the possible exception of the FUSULINA and other small types. The state of the fossils indicates alteration changes. The flint in local areas has a banded and orbicular structure which shows secondary arrangement of the matter. Replacements in many of these beds are evident, but it is uncertain how much is to be accredited to the early stages of formation and how much to the later.

"Taking the third view next into consideration, the original rock is a regularly deposited limestone covered by later sediments. Circulating ground waters holding soluble silica and organic components in solution attack the limestone, taking calcium carbonate into solution and depositing silica in its place.

The flints are thus of secondary origin. The chemical action involved is the same as it is in the second case, except that it is performed through the medium of circulating ground waters in place of salt brines. The change is effected under less favorable conditions, but the force is operative over a longer time interval. The action began with the covering of the bed by later sediments and is still effective. The question is whether the action of ground waters is sufficient to change thick beds of limestone extending over wide areas to strata of flint. On the Boggs horizon the flint is from a few inches to 1 foot 6 inches thick, and is rather local; on the Upper Mercer horizon the volume varies from 1 foot to more than 10 feet, and it is very persistent over a wide area, and on the Ferriferous horizon it varies from a few inches to 10 feet, and is often continuous for several miles. The variation in the character of these members is shown under the discussion of their stratigraphy.

"The work of ground waters in effecting the solution of one component and the substitution of another is well known, and this action accounts for the nodules of flint in many of the massive limestone and chalk beds. It is a question, however, as to whether this accounts for the origin of the thick beds of flint in the coal formations of this area. Where the section was measured on the Lee Moore farm in Jefferson Township, Coshocton County, the lower layer is composed of irregular masses of relatively pure flint and limestone which are distinctly separated, but with the flint constituting the greater part. Replacement of calcium carbonate by silica is strongly suggested. Above this layer, there is 11 feet of thin to medium-bedded shaly limestone containing practically no flint, and directly overlying this shaly limestone there are two layers of flint which are only slightly calcareous at most, and which contain no large irregular masses of limestone. If these two beds were originally limestone the transformation from limestone to flint has been quite complete. The series thus shows limestone beds lying between flint strata. If these flint beds were formed through the action of circulating waters on limestone, subsequent to the formation of the entire deposit, then the limestones occupying the middle of the deposit should also show evidence of the same influence, which is not the case. The structure of the deposit, therefore, seems to show that these rocks were laid down in about the same condition as that in which they are now found."

MEANS OF IDENTIFICATION OF FLINT.

Flint objects found upon the surface of practically every portion of Ohio are very often difficult to identify as to source.

The flint from Flint Ridge varies greatly in different parts of the deposit, but in the region of the pits the flint is very compact, almost free from impurities, and possesses all the colors and shades found in flint. Much of the flint is blue or a grayish-blue translucent chalcedony. In some places a glassy variety is found in connection with the grayish-blue variety and ranges from almost perfect transparency to complete opacity. In another section jasper predominates, with a wide range of color from dark red through the various shades of yellow; also a banded, or ribbon variety, with alternating stripes of light and dark gray, brown and black.

In the central part of the great pit region southeast of Clark's blacksmith-shop the flint has practically all been removed from its bed, and here is found the most beautiful of the various colored chalcedony showing the tints of blue, red, green, purple, brown, yellow and white.

A careful examination of specimens of flint collected from the various quarrying sites and the workshops is a necessary aid in identifying the flint after it has been made into objects by primitive man and carried to remote places.

In 1898 the writer undertook a microscopical study of the flint from Flint Ridge with a view of determining the original home of flint specimens found upon the surface in practically every part of the state, as well as specimens taken from mounds and village sites. More than 100 thin sections were made and studied. The specimens from which the thin sections were cut were secured from pits where the flint was quarried and from the workshops nearby. Thin sections of flint from other known quarries in the United States and Europe were made for comparison. The microscopic thin sections from the Flint Ridge flint proved of special interest and value as a means of identification, as many forms of siliceous foraminifera as well as siliceous sponges were in evidence, which would readily identify the Flint Ridge flint.

Only a few of the microscopic thin sections from Flint Ridge show diatom fragments and a few show nothing definite in the way of fossils, but the general appearance of the compact

crypto-crystalline mass of chalcedonic silica as shown by the microscope was a great aid in determining the Flint Ridge flint when compared with flint from other sections.

QUARRYING

The primitive inhabitants of Ohio made use of various kinds of rocks found in the drift, where the agents of nature — the glacier and floods,— had with almost human discrimination deposited the tough granites and quartzites in convenient places for man to select and reduce to available size and form But the flint, so highly prized for the manufacture of arrow and spear-heads, occurs only in well defined areas, where the outcrop was available and served as a guide to the location of the great deposit a few feet under the soil.

Quarrying the flint really begins with the removal of a fragment from the exposed mass or from the ground where it was partly buried. It is only a step further when the mass of the flint is uncovered, and the flint removed on a large scale.

EXTENT OF OPERATIONS.

The extent of quarry operations in the region where the valuable flint is found centers around the Cross Roads, three miles directly north of Brownsville and known as Clark's Blacksmith Shop. A circle with a diameter of one mile with the center at the cross-roads would enclose about all the sections quarried, and the extent of the quarried area within this circle would not exceed 100 acres. When we take into account that practically all of the flint used by the various cultures representing the prehistoric Indian in Ohio came from the Flint Ridge region, we can readily understand and appreciate the importance of territory quarried. All trails leading in the direction of Flint Ridge would end there, or in other words, Flint Ridge was the trailsend of the prehistoric Indian in Ohio. The accompanying map, Fig. 3A, indicates the general distribution of the flint deposit as well as the location of the quarries as indicated by excavations over the entire area.

THE FLINT STRATUM.

The flint stratum is very irregular in thickness and at no place examined did the flint exceed six feet in thickness, although other reports from various sections give a thickness varying from five to ten feet. Directly north of the cross-roads the stratum measures fully six feet, while following the pitted section due north to near the edge or outcrop, the depth of the flint measures only eighteen inches, and the top and bottom of the deposit become very irregular and more or less nodular in form. The weathering out of small fossils and calcite crystals, which appear in great abundance near the margins, makes the flint appear cellular or porous in structure. This condition prevails in the greater bulk of the flint found on the ridge. Consequently prehistoric man discovered that the greater part of the flint was of no value for the manufacture of artifacts and accordingly concentrated his efforts upon the material that would best meet his requirements. This was limited to two sections; namely, the region of the cross-roads, three miles north of Brownsville, Licking County, and the region of the Flint Ridge School, Hopewell Township, Muskingum County. The territory quarried over in these two sections would perhaps not exceed 100 acres in extent.

METHOD OF QUARRYING.

After our examination of many of the quarries upon the "Ridge" the most striking and marvelous phenomenon is that the aborigines ever accomplished the removal of such a thick stratum of flint over a so comparatively large area. Only those who have ventured to remove the flint from its natural bed with modern tools can appreciate the skill and perseverance necessary in wresting from nature the flint needed in fashioning the many artifacts, with such primitive tools. These tools are found in abundance over the entire site and in many instances where the ancient quarryman had left them.

Mr. Gerard Fowke, while in the employ of the Bureau of Ethnology, made a systematic study of "Flint Ridge" and his report appears in the annual report of the Smithsonian Institu-

tion for 1884, and in his work entitled the "Archæological History of Ohio" published in 1902. Mr. Fowke spent much time in a personal examination of the entire "Ridge" and his recorded observations on the method of quarrying the flint are of especial interest and value. I quote from his report to the Bureau of Ethnology, published in Smithsonian Report, 1884, page 864:

"How these ancients knew where to find the best flint for their purposes, unless indeed these sites were chosen at random, cannot be told. It also remains a question as to how the flint was quarried after its location was determined. No doubt a thorough examination of some of these pits will throw much light upon the methods in use among them for obtaining the raw material."

Quoting further from the same report, page 867:

"The aborigines (meaning thereby Indians, Mound Builders, or whatever other name may be assigned to the people who did this work) knew that by digging into the unweathered bed-rock a quality of flint could be obtained better suited to their purposes than that which could be procured along the outcrop. The dirt was cleared away, by being carried out in baskets or skins, until the flint was exposed. Cleaning out a space sufficient for working purposes, a fire was built on top of the rock, and when it was heated water was thrown on it. This would cause the rock to crumble, and on clearing out the fragments a fresh surface of flint would be exposed around the hole thus made in it, from which pieces could be broken off with the large boulders found in the vicinity. A question presents itself here, 'If this method was used, why did they not follow the flint stratum, once they had found it, throwing the dirt behind them, instead of opening so many fresh holes?' The only answer to be given is that they did not, except in a few instances, and that is all we know about it."

Later, Mr. Fowke in his book "Archæological History of Ohio", page 622, goes into detail concerning the quarrying of the flint by the use of fire:

"The pit taken as an illustration was at least forty yards from the one nearest to it; it was thirty-two feet in diameter inside of the wall of earth surrounding it, which wall is now two feet higher than the general surface around it, and from twenty to thirty feet across at the base. This form indicates

considerable age; as does an oak tree nearly ten feet in circumference, growing on the top of the wall. In clearing out this pit we could appreciate the patience and industry of the aboriginal excavators. The clay subsoil was as hard and tough as frozen ground; frequently half a dozen blows with a pick were required to break off a clod as large as a man's hand. To remove it with primitive tools seems almost an impossibility. The central part of the pit was filled with material that had washed in from the sides. Several days of steady digging were required, by three men accustomed to such work, to reach the surface of the flint stratum, which was found at a depth of nine feet. A hole five by eight and one-half feet had been worked through; clearing this out, we found the layer to be forty inches thick. It rested directly upon a solid bluish limestone. Both the flint and the limestone showed that they had been subjected to an intense heat. The flint was very solid where not burnt, translucent, and a beautiful light-blue in color. On its top, on a corner formed by two seams, was a saucer-shaped depression between three and four inches deep, in the bottom of which was a handful of very fine chips; just such as would result from repeated blows with a large hammer-stone, several of which were found scattered through the entire depth cleared out. One of them weighed nearly or quite a hundred pounds.

"Careful observation of this pit — and others as well — enables us to follow the prehistoric quarryman in his labors. He selected a spot where he thought the superincumbent earth not heavy enough to render the task of removing it too tedious, but at the same time was of ample thickness to prevent injury to the stone from weathering. He then sunk a pit, as large as he wished, to the surface of the flint. On this he made a fire; and when the stone was hot he threw water on it, causing it to shatter. Throwing aside the fragments, he repeated the process until he penetrated the underlying limestone to a depth which allowed him sufficient room to work conveniently. The top and freshly made face of the flint was thickly plastered with potter's clay, after which fire and water were again utilized for clearing away the limestone until a cavity was formed beneath the flint layer. Thus a projecting ledge would be left, from which the burnt parts were knocked off with heavy stone hammers until the unaltered flint was exposed; in the same manner, blocks of this were procured for converting into implements. Where the flint was well suited for the purpose intended, or was easily worked, the excavation was carried along in the form of a trench, the waste material being thrown to the rear; under less favorable conditions the spot was abandoned."

Our examination of the quarries upon Flint Ridge, made with a view of ascertaining the method of quarrying, does not bear out and verify the findings of Mr. Fowke concerning the use of fire as an operating agent. On the other hand, the evidence found concerning the use of fire as an agent in quarrying the flint was purely negative, and I doubt very much if fire was used at all as an aid in removing the flint from its natural bed. I will go into detail concerning several of the sites examined, quoting from my field notes made at the time of the excavations.

After a general examination of the "Ridge" in company with my assistant, Mr. Shetrone, we marked a number of places for examination, and this plan was systematically carried out. The first pit for examination was located in the woods north and east of the blacksmith-shop, about 300 feet north from the road running east from the cross-roads. The property is owned by a coal company with headquarters at Newark, and is under the direct supervision of Attorney R. E. Jones, who aided us in every way to make our work successful.

The pit was selected with a view of finding the full vertical ledge of flint exposed as the aboriginal quarryman had left it. In this we were partly successful, the vertical ledge of flint measuring three feet and seven inches, while one foot and eleven inches of flint had been removed from the top surface for a space of six feet by eight feet. The flint on the top appears in nodular-like flat masses, from two to three and one-half feet in diameter, and the ancient quarryman, taking advantage of the seams between the nodules, was able to work downward until the more desirable flint was exposed. The top of this quarry was covered with about seven inches of soil, accumulated during the more than a century since the early settler came to occupy the land. The top surface of the quarry was more or less irregular, caused by the early quarryman following the cracks or seams, or the lines of least resistance in his operations. Not the slightest indication was found in this quarry to show that fire had been used to supplement the hammerstones, several of which, varying in size from about a pound to one weighing upward of twenty-five pounds, were found in the pit. The hammerstones were made of granite and quartzite.

General indications shows that wedges, perhaps made of wood or horn, were used in dislodging the desired pieces of flint.

Fig. 4 shows the face of the quarry where the flint is three feet and seven inches in thickness. On the top of the flint lies a large hammerstone of granite, weighing about twenty-five pounds, which was found at the bottom of the pit. A close inspection of this cut will show the cracks and seams found in the flint, which we later quarried out to ascertain why this part of the stratum had not been utilized. We followed the seams, using iron wedges instead of wood and iron hammers instead of stone, and thus were able to effect our purpose. The flint was found to be practically worthless for making into artifacts, and the entire mass of three feet and seven inches in vertical height, two feet in thickness, and three to four feet in length would have been quarried out and cast aside in order to carry forward the quarrying operations, with a vertical wall or nearly so to work from. The ancient quarryman apparently did not perform such arduous labor to secure the coveted flint unless absolutely necessary, as was found to be true in many of the quarries examined in the various sections of "Flint Ridge".

We also quarried samples of the good flint exposed on the top of this quarry and found the prevailing color to be a light blue-gray, translucent in thin sections, but frequently varying in color from a dep red and yellow with shades of lilac. In many instances, seams of translucent chalcedony extended into the mass of the flint, sometimes only about one-eighth of an inch apart, giving the flint the appearance of banded agate. However, this banded flint when struck with a heavy hammer would separate into needle-like forms which made the flint worthless as far as primitive man was concerned. The lilac-colored flint from this quarry was often filled with very small geodes of quartz crystals, which did not greatly interfere with its use as implement-making material.

Adjoining the lilac-colored flint was a slightly yellow-colored flint containing much chalcedony and larger clusters of quartz crystals. The ancient quarryman had uncovered a cluster more than six inches in diameter, the crystals ranging in size up to one-half inch in diameter, colored a light amethyst, and very

FIG. 4. Face of quarry showing the flint to be three feet, seven inches in thickness.

beautiful. Another very interesting deposit of flint, known as the brecciated form, was found in the highly colored red flint in this quarry. These deposits are not much larger than a man's fist, are usually oblong in general form, and are made up of small angular fragments of flint which seem to have been held in suspension in clear or slightly colored chalcedony.

After the work of examination of Pit No. 1 was completed, a good opportunity to try the experiment of quarrying by the use of fire presented itself, for here was the bed of flint uncovered and an abundance of dry wood at hand. The fire was kindled, and was kept burning for two hours, producing an intense heat on the underlying face of the flint. The fire was then removed and two buckets of cold water were thrown upon the surface. I fully expected the flint to break in large pieces, but it merely checked and cracked into small pieces to the depth of perhaps half an inch. After the conclusion of this experiment it was apparent that fire as a direct agent in the quarrying of flint was perhaps not effective. In this connection I may state that at no time during the examination of more than twenty-five of the pits and quarries in this section was there evidence of the use of fire in the quarrying of flint. In several instances small amounts of charcoal were found in the pits, but so sparingly as to indicate that fire was in use around the quarry but not as a direct agent in quarrying the flint.

The next quarry of special interest was No. 3. This quarry is located not far from the outcrop along the cleared field on the Coal Company's property, perhaps a little more than half a mile directly north-east from the blacksmith-shop. The pit was seventeen feet long and fifteen feet wide, and at no point in the quarry had the bottom of the flint been reached. Near the center of the quarry, to the west, a projection of flint extended almost across the quarry. Examination showed that the deposit was a very compact variety of yellow flint, practically devoid of seams, which baffled our own efforts at quarrying with our modern chisels and hammers. We were very desirous of securing large samples of this highly-colored flint, and preparing the stone for a charge of dynamite, were able to secure good specimens of both yellows and reds. Many instances exist on the

Fig. 5. Shows the quarrying of the flint from the top. At no place was the flint entirely removed.

"Ridge" where the ancient quarryman was compelled to abandon the removal of fine flint, owing to the absence of cracks or other defects which would enable him to work through to the base of the deposit, and thus gain a vantage point for further procedure. Our blast removed the flint for about two feet in depth and it apparently had the same consistency throughout.

This quarry is shown in Fig. 5. The projection of flint which the aborigines could not detach, and that portion of the quarry directly to the north, are shown. The flint was quarried from the top and shows many places where cracks were followed and the flint removed. Fire was not made use of, as no charcoal or other indications of heat were present. This quarry was noted for its highly-colored flint, both red and yellow, and the number of hammers, large and small, found on its floor.

Pit No. 4, shown in Fig. 6, is of special interest, as the flint is exposed on two sides of the pit, for a distance of almost six feet. Cracks in the flint are quite noticeable. The crack appearing at the angle of the two walls is quite large and evidently the face of the exposed wall follows this crack. The quarryman at this point worked from beneath. He found the lower stratum of flint could be detached something like limestone, as evidenced by the finding of slabs of flint a few inches thick and eighteen inches across, while in another quarry nearby slabs of flint that had been quarried from the bed but not removed, measured three feet in diameter and two and one-half inches thick. The flint offering the least resistance to detachment seemed to be at the bottom of this quarry. This flint was of practically no use to primitive man but by its removal he was able to reach the good flint which, in this instance, is practically in the center of the ledge. Many large single crystals of quartz, measuring from three-fourth inch to one inch in diameter were found in the debris of the pit, and some very large geodes of large-size quartz crystals lay near the bottom of the quarry. Large pieces of rock-crystal were found in the workshops not far from this region and we have in the museum a single crystal three and one-half inches in diameter and five inches long, secured and presented by Miss Clara G. Mark. Miss Mark obtained the specimen, which

was reported found on Flint Ridge, while making a study of the region. With the surface finds of large pieces of rock crystal, it would not be unreasonable to expect to find very large crystals or masses of rock crystal, in future quarrying of the flint.

FIG. 6. Pit in which flint is exposed on two sides.

Pit No. 8 was an excellent example of quarrying from the top of the ledge. The pit is located about 200 yards from pit No. 4, further within the woods of Mrs. Loughman's farm. The pit was quarried from the east and extended into the solid flint eight feet with a width of seven feet. Here was a very good opportunity to clear out the quarry and take note of the

three exposed sides. It was soon discovered that the quarryman was guided by two cracks in the flint running east and west and about seven feet apart. On the north side the crack was two and one-half inches wide and on the south a scant two inches wide. In the north-west corner of the quarry was a large piece of flint, measuring three feet long and almost two feet thick that had been broken loose when the rents split the rock. The break was caused by a large cavity in the flint filled with beautifully colored crystals of green, yellow and red. At this point a crack occurred north and south and was perhaps one-half inch wide. The flint was six feet in thickness and the cracks extended the entire depth of the flint. The flint, although very crystalline, was of good quality for making knives and arrows. The color was a light gray with blended shades of red and yellow and often certain sections would shade into a leek-green, very likely due to the presence of a trace of iron silicate.

The flint had all been quarried and removed from the pit and at no point at the base of the flint were there indications of quarrying under the mass. However, on the top of the west wall, the earth had been removed and the top of the flint quarried out in several places to the depth of perhaps a foot, showing that the quarrying was carried on from on top. Many broken and perfect hammer-stones of granite were in evidence in the quarry, but there was no indication of the use of fire.

Pit No. 9 is located in the Mary Loughman woods near the north line of her property and about 200 yards east of the northwest corner of the tract. The quarry was very much like No. 3, as the quarrying was all carried on from the top of the deposit and at no place in this quarry was the bottom of the flint exposed. A good photograph of this quarry is shown in Fig. 7. The quarry is fifteen feet long and twelve feet wide and the photo shows practically the entire pit as the primitive artisan had left it. The large mass of flint suitable for the making of artifacts is shown to the right in the photograph. The useless flint had been taken out from three sides and the photograph shows that the removal was under way when the quarry was abandoned. We removed the large block of flint, which

FIG. 7. Quarry showing the suitable flint for chipping exposed.

was of very good quality and practically devoid of the small drusy crystals so common in this quarry. The color of the flint is a light gray with a shading of purple, red and yellow. The block of flint shown to the left in Fig. 7 is a light drab in color and the crystals shown on its top are quite large, some of the individual crystals found broken from the clusters measuring three-fourths of an inch in diameter. Very little chalcedony is found in the flint left in the quarry, the flint which doubtless was of especial value because of its quality and abundance. The manner of quarrying is here best shown of any of the quarries uncovered.

Pit No. 14 was of great interest. It is situated in the east end of the Mary Loughman woods. The flint at this point is covered with a very light covering of earth. After the earth was removed from the flint it had the general appearance of a large flattened nodule ten feet in diameter. Primitive man had quarried off about one-third of the nodule, and found the center contained a very large crystal of heavy spar, light blue to yellow in color. We quarried out the crystal of heavy spar and found it to measure more than four feet in length, two feet wide and about fifteen inches in thickness. When first found the spar was perhaps a solid mass, but in time it became cracked, as shown in the cut, Fig. 8, with the exception of the center which was removed intact. Heavy spar, varying in color from lemon yellow to light blue is found in connection with workshops and apparently is associated with the flint in many of the quarries. Its use by primitive man is not apparent, as no artifacts made therefrom have been found in Ohio. Perhaps its extreme weight attracted the attention of the primitive quarryman.

In all twenty-five different quarry sites were examined in the vicinity of the cross-roads and no evidence was obtained showing that fire had been used as an agent in quarrying the flint.

The examination was extended to the eastern end of the "Ridge" in Muskingum County, where evidence of quarrying was found upon the farm of Mr. James Boyer. Mr. Boyer, like many of his neighbors, is a progressive farmer and all were

FIG. 8. Large crystal of heavy spar ranging in color from light blue to yellow. The crystal is shown in the center of the picture.

anxious to assist our survey in granting permission to examine quarry- sites on their respective farms, as well as by presenting specimens of flint found in the region. On Mr. Boyer's farm the quarrying is more extensive than anywhere in the vicinity. The flint is a light gray in general color, very often mottled with subdued gray and brown shading to dark brown.

A quarry-site located in Mr. Boyer's orchard was selected and a space fourteen feet long and six feet wide was removed to the depth of six and one-half feet, where we found the original bed of flint. Of this, about one foot remained in the quarry, except at the south side, where the entire bed had been removed, apparently by the same method of quarrying as was employed at the cross-roads in Licking County. The general blocking out was done at the quarry or along the hillside less than fifty feet away. At no point on the spur of the hill where the orchard is located is there an outcrop of the flint. Apparently the flint has all been quarried out and worked over and the refuse left at the quarry-site, as indicated by the five hundred or more cubic feet of broken pieces removed in the examination of this quarry. Practically no earth was mixed with the flint after the surface had been removed, insects of various kinds being found to the bottom of the quarry as well as the short-tailed shrew (Blarina brevicanda) which was found very frequently during our explorations. This small mole is truly insectivorous and had its habitat in the region where food was abundant.

In the woods north of the orchard on Mr. Boyer's farm is an outcrop of flint, the remains of an ancient quarry. The debris was cleared from this quarry, disclosing that the flint had been removed to the bottom. The perpendicular wall shown as an outcrop was one side of a large crack in the flint, extending almost perpendicular through four feet of the top of the deposit, then deflecting under the ledge. The flint had all been removed to this break in the deposit, and the work of removing the soil on the top preparatory to further quarrying was under way when the quarry was abandoned.

In all, thirty-three quarry sites were examined by the survey, — twenty-five in the region of the blacksmith shop located at the cross-roads, Licking County, and eight in the region of

Mr. Boyer's farm in Muskingum County — and all showed the same use of the hammers and mauls in quarrying the flint. Perhaps the hammers were used in conjunction with wedges made of wood and bone and these latter in connection with large and small wood pries or levers. However, the use of wedges and pries is only conjecture, as no direct evidence in the thirty-three quarry-sites was found to substantiate this assumption. However, we feel the primitive quarryman would use the simplest tools that would accomplish the desired results and that these would be wedges of wood and bone and pries both large and small of wood.

MANUFACTURE OF FLINT ARTIFACTS.

The first step toward the manufacture of flint artifacts is securing the raw material by quarrying and the first step in shaping this raw material, whether by breaking, flaking or chipping, by percussion or pressure, was the "roughing out" of blades and cores into convenient sizes. In this handy form they were transported to practically all sections of Ohio, where caches have been found in old village sites and in mounds.

As stated in the Introductory Note, perhaps the three well defined steps in the preparation of raw material noted would give rise to three separate industries carried on by the same individuals at different times or places or by different groups of experts trained in their respective industry.

The first industry was that of quarrying which has been fully described in the foregoing pages. The second industry was the blocking out of selected pieces of flint into general form and testing of the raw material before it is taken to the workshop. Very good examples of blocked-out flint are shown in Fig. 9. The blocked-out specimens found so abundantly at the "Ridge" range in length from twelve inches to three inches and in width from five inches to two inches. They are frequently found near the quarry but the largest numbers are found in the workshops where the blades are finished. When found near the quarry they are usually broken, showing that the piece of flint was defective. The blocking-out was perfected by the

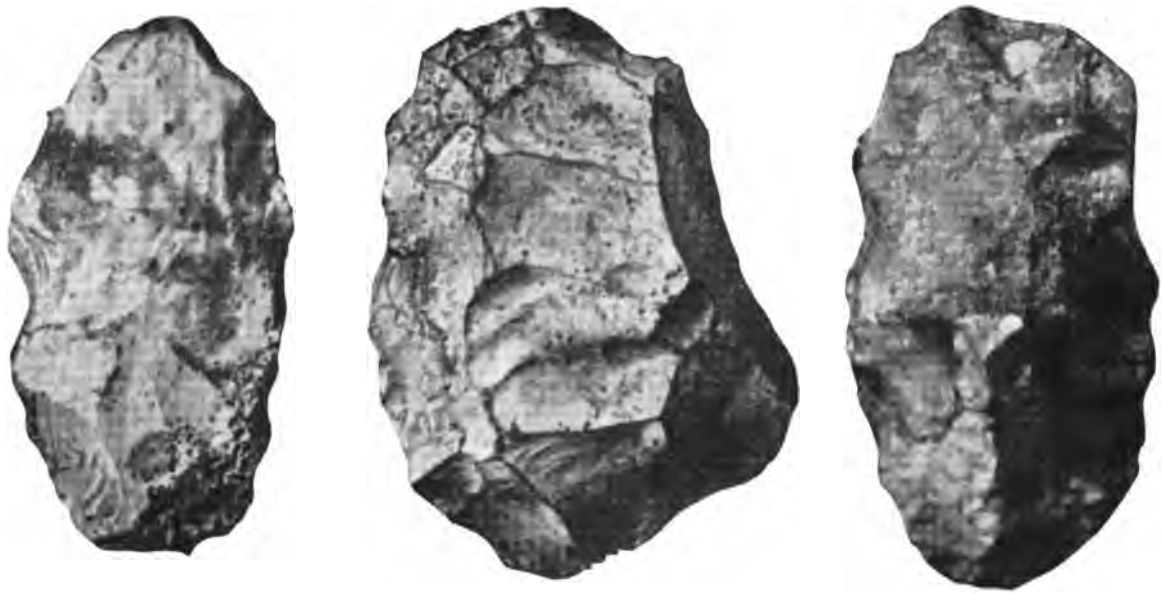

FIG. 9. Blocked out flint ready for the workshop.

use of hammers, very much smaller than those used in the heavy quarrying, and ranging in size from three and one-half inches to two and one-half inches in diameter. These were frequently found in the work-shops, but were more abundant in the region of the quarries (see Fig. 10). The hammers were made for the most part of granite, and had to be transported to the "Ridge". However, hammers made of flint were frequently found in the section surrounding the blacksmith shop, and were as abundant as the granite hammer in the Boyer section in Muskingum County. The hammers shown in Fig. 10 are made of granite, the specimens to the left and the one in the center being round and the specimen to the right a flattened cylinder. Fig. 11 shows six very choice hammers. No. 1, a highly con-

FIG. 10. Small hammerstones used in blocking out the flint.

ventionalized hammer, has the general appearance of a discoidal stone and is made of granite. No. 2 is a flattened cylinder made of flint. Nos. 3 and 6 are round, of granite. Nos. 4 and 5 are round and made of flint. During our entire exploration work upon the "Ridge" only one hammer with provision for the attachment of a handle was noted. This specimen was found by Mr. E. F. Fink, who owns a farm in the region of Mr. Boyer's, Muskingum County. The hammer is shown in Fig. 12. It is made like the cylindrical forms, with a deep groove for the attachment of a handle cut across the flat faces. In many sections of Ohio grooved hammers are very abundant and often rival the grooved axe in numbers. The question has often been asked by those interested in quarrying, why is the grooved

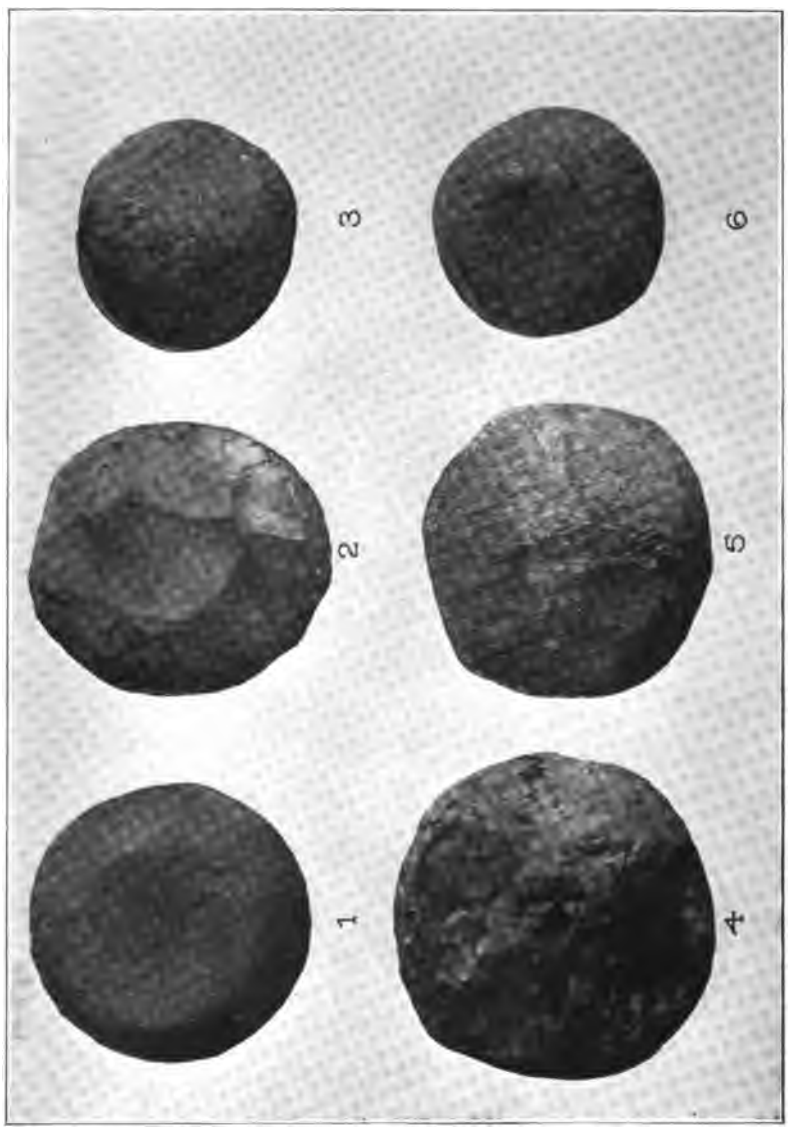

FIG. 11. Hammerstones made of granite and flint.

hammer absent from "Flint Ridge" when it is so universally used throughout Ohio, while at the aboriginal copper mines of Michigan large grooved hammers and mauls are often met with? The answer seems quite apparent when the mining of the copper is properly studied. The native copper was all the aboriginal miner was seeking, and very often the metal was surrounded with a very hard rock. All that was needed was to crush this rock with a hammer-blow that had back of it force and power, but not necessarily accuracy — a force which could be obtained only with a hammer attached to a handle. On the other hand,

FIG. 12. Hammerstone with a groove for the attachment of a handle.

the quarrying of the flint required force applied with accuracy, and the ancient quarryman learned that a hammer attached to a handle was not a very accurate way to apply force to the flint; but he did learn that force applied directly with a dexterous hand was what was needed in quarrying the flint. Afterward, in shaping the flint, he learned that the shaping by percussion required a certain size of hammer, that the blows from this hammer must be accurate or the specimen would surely be lost by breakage, and that the correct blow could only be delivered with the handleless hammer held in the hand.

The third industry connected with the manufacture of flint implements is the shaping of the blocked-out pieces into blades ready to be transported, with the smallest amount of superfluous flint, to distant parts of the country. The blades were all shaped in the workshops, which often were located in close proximity to the quarry, in many instances only a few hundred yards distant. On the other hand, the workshop might be several miles away; in fact both Licking and Muskingum Counties contain many sites of workshops. A very noted workshop is located a short distance north of Granville, showing that the blocked-out flint was carried some eighteen to twenty miles from the quarries.

The leaf-shaped blades manufactured in the workshops were of two types, the square base and the round base. The round-based blades were usually larger. A fine example of the round-base blade is shown in Fig. 13. The length of this blade is six and three-fourths inches and the width three and five-eighths inches. The square-based blade shown in Fig. 15 was found in a workshop some five or six miles from the quarry. Its length is six and seven-eighths inches and width three and one-eighth inches. These two specimens are excellent examples of the highest art in blade making and represent the average blades from which large spear points were manufactured. The blades are made in all sizes, ranging from the large size down to about two inches in length. From these blades all forms of arrow-points, spear-points, drills, knives and scrapers were made as needed by those living in remote places from the quarry.

Not all blank forms of flint brought to the workshops proved of value for making into blades, as many of the blanks have more or less obvious defects, some being excessively thick in some part while others are crooked or defective in general outline. Even in a perfect piece of flint, after the form had increased in tenuity the danger of breakage also increased, as shown in Fig. 16. In this figure, the square base form, the blade was practically complete, when an extra blow with the hammer rendered the piece worthless. In Fig. 17 is shown the round-base leaf-shaped broken blade, which was as common as the square base. The workshops show many broken blades

FIG. 13. Round based blade of large size found in the workshops.

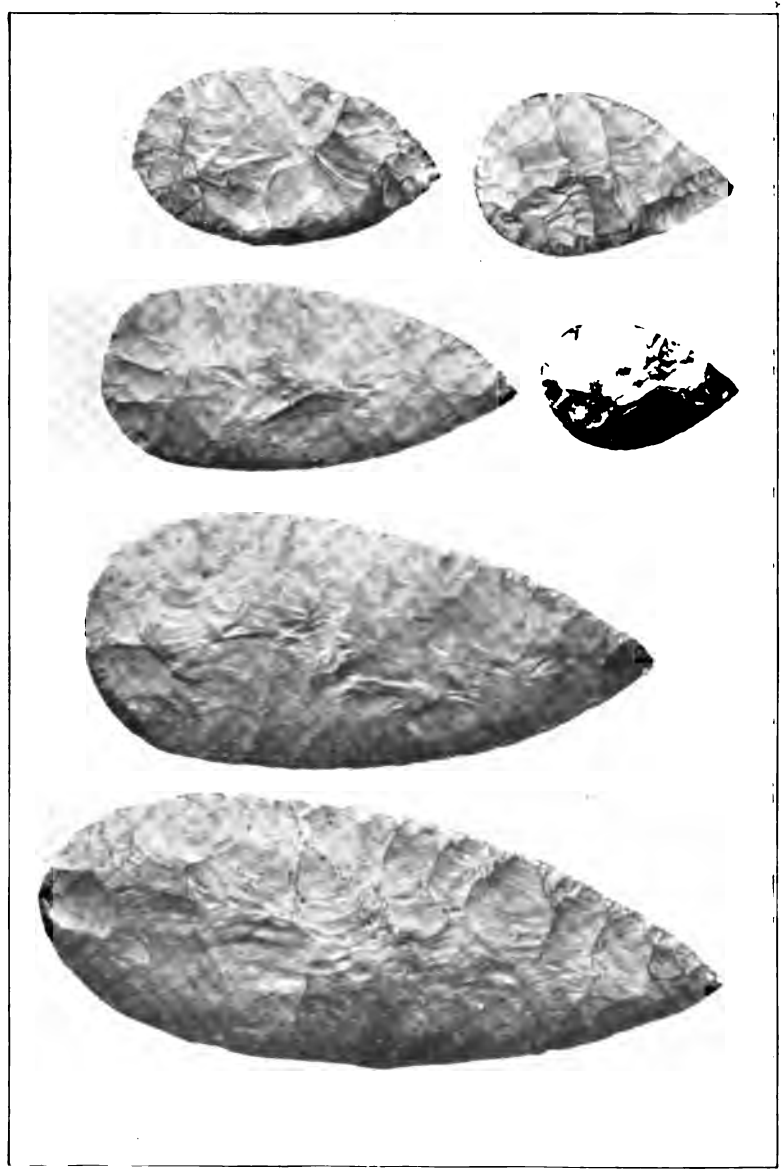

FIG. 14. Shows practically all of the various sizes of blades found in the workshops.

FIG. 15. Large square based blade found in a workshop some distance from the quarry.

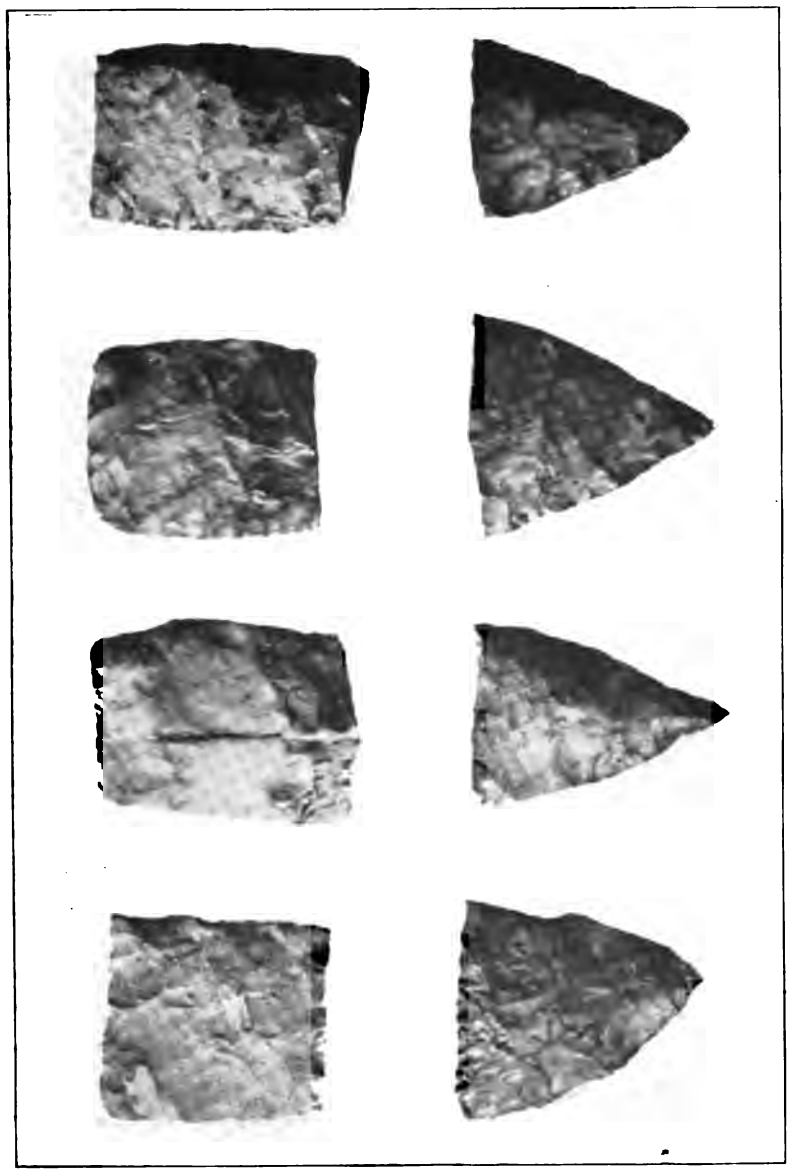

FIG. 16. Shows broken square basel blades found in the workshops.

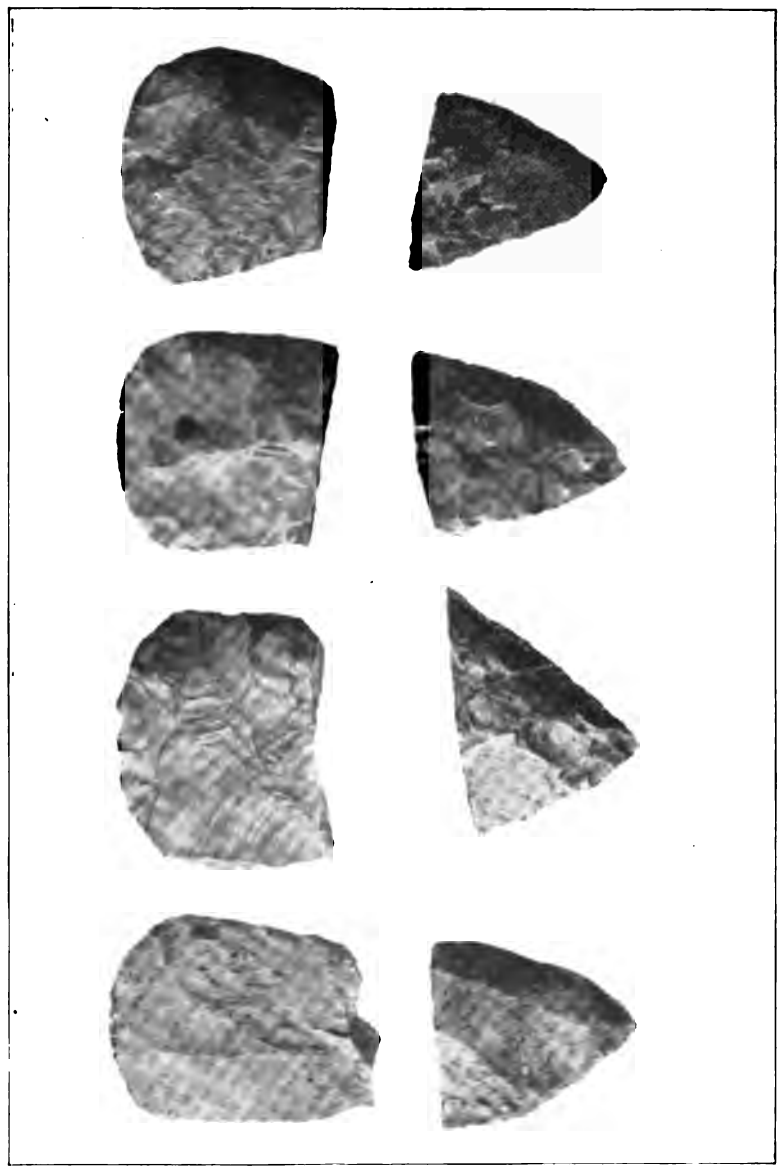

FIG. 17. Shows the round based broken blades found in the workshops.

In one workshop, south of the blacksmith shop along the Brownsville Road, the writer found upon the surface fifteen broken blades within a space of five feet by six feet, and I am safe in the assertion that many hundred broken blades may be found upon the surface in the workshops surrounding the region of the blacksmith shop.

In the process of shaping the blades, many eccentric forms are necessarily developed, due for the most part to defects in the flint itself or to the non-flakable quality of the flint found in conjunction with good flakable flint. Many of these forms are shown in Fig. 18. Specimens are often found showing that one side has reduced readily and given the proper convex surface, while the other side worked badly, giving a high hump attempts to remove which usually ended in breaking the piece.

The shaping-tool used in perfecting the leaf-shaped blades was no doubt the small hammer so abundantly found in the workshops. Good examples are shown in Nos. 3 and 6 in Fig. 11.

The second industry developed at Flint Ridge was the manufacture of cores from which knives were flaked. This industry was confined for the most part to the workshops south and southeast of the blacksmith shop. At no other point have many of the specimens been found, the form being considered rare when found outside of this region.

The cores are especially prepared flint blocks, so shaped that long flint knives can be flaked from the core. The flint used in making the cores is usually highly colored chalcedony, many of them showing various tints of blue, red, yellow, green and purple.

Excellent examples of cores are shown in Fig. 20. No. 1 core is made of lemon-yellow flint with splotches of bright red at the thick end. No. 2 is made of a purple flint with streaks of red running through one side. This core shows knives chipped from two sides. No. 3 is a very highly colored core. The top, as shown in the cut, is a very dark rose with a decisive change in color to green, and the green shading to yellow. The knife shown in No. 4 was flaked from this core, fits nicely upon it and is the first instance of finding the knife and then the

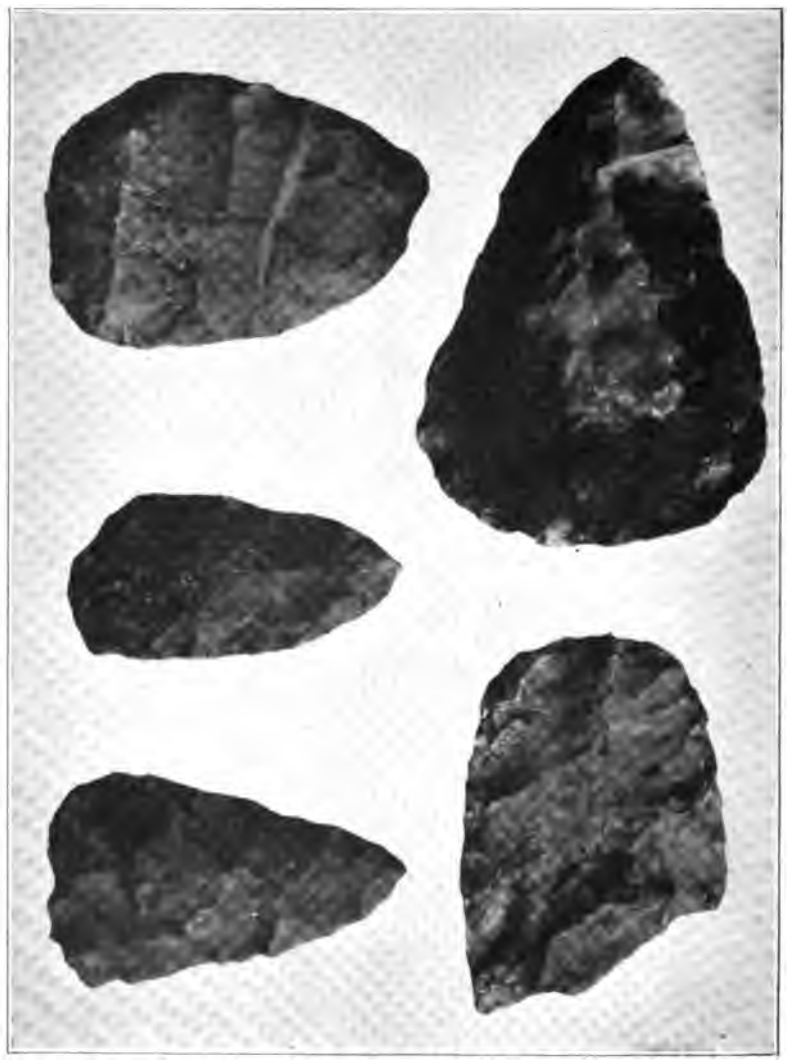

FIG. 18. Showing defects in the flint which makes the flint undesirable for chipping.

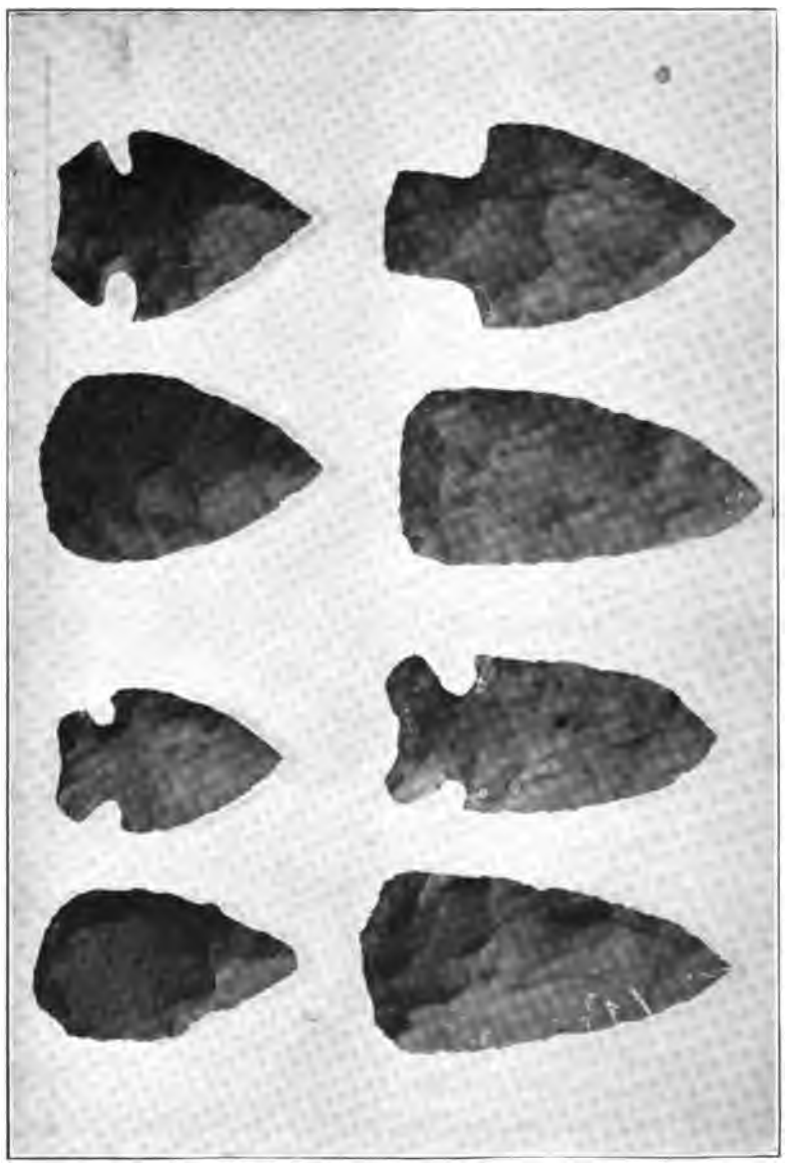

FIG. 19. Shows the blades as well as the points manufactured from them.

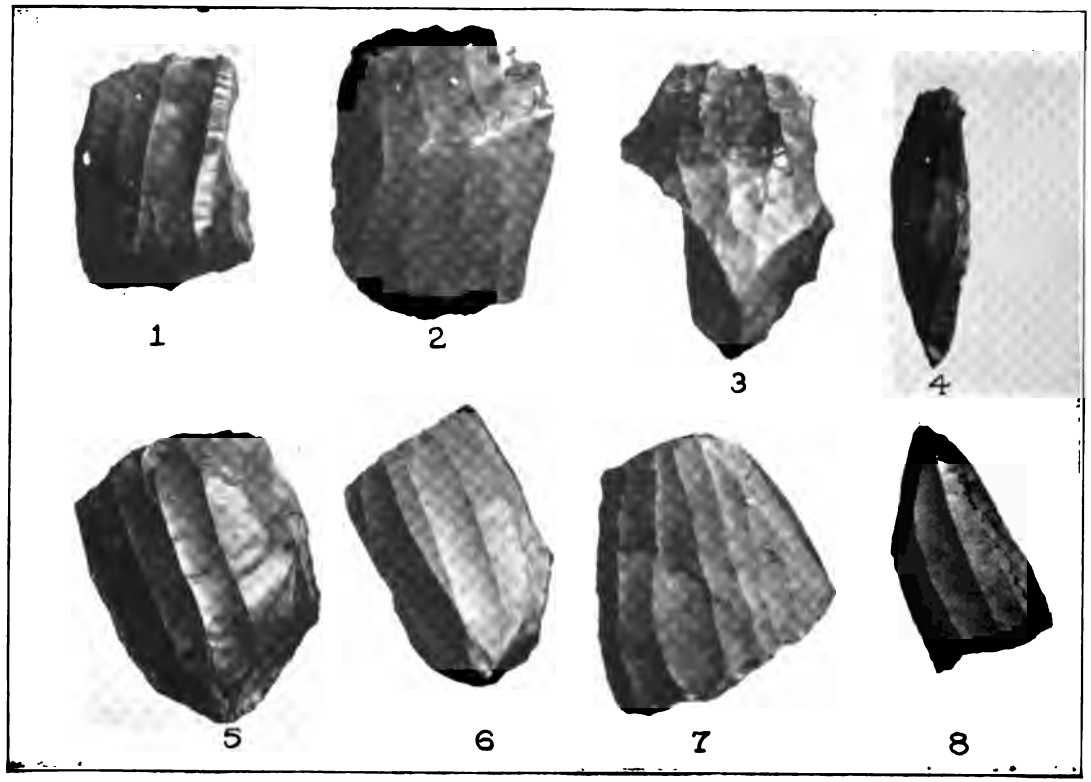

FIG. 20. Flint cores from which knives are chipped, found so abundantly in the workshops.

core from which it was flaked. No. 5 is a very dark red, with a large splotch of green near the center of the piece. No. 6 is a very delicate shade of yellow with a blending to dark rose. No. 7 is a light shade of yellow blending into purple with streaks of very dark red. No. 8 is an unusual blending of the various shades of green.

Knives flaked from the cores are found in great numbers in the workshops, especially in those south and east of the cross-roads at the blacksmith shop. Good examples of flaked knives are shown in Fig. 21. Many of the cores were subjected to the process of flaking off the knives, and were then discarded, at the workshops; while some of them, we find, were carried to distant points where they were utilized as needed. We find the knives in goodly numbers in the old villages and mounds, and occasionally cores are found; but nowhere in Ohio can either be found in such numbers as at the workshops of "Flint Ridge". The workshop at the end of the Mary Loughman woods and the workshop directly south of the dwelling on the Graham farm are both very rich in knives and cores.

The workshop on the Graham place is practically the only place on the "Ridge" showing a continued habitation. Broken pottery, animal bones of many kinds, and other general indications show a more or less permanent habitation. This workshop has been under cultivation many years and the small delicate knives would naturally get broken, but a careful search by our survey gave us more than one hundred perfect cores and scores of blank cores ready for flaking, as well as many hundreds of perfect knives. The industry at this site was not confined to the making of cores and knives, but the making of blades of the round and square base type was much in evidence, as more than a hundred broken blades of each type were found. Occasionally a finished arrow-point was found on the site, several of which were made of a dark to black flint, the spawls of which are seldom found in the shop site, indicating that perhaps these specimens were lost by hunters or received in exchange.

In one of the workshops, my assistant, Mr. Shetrone, found a large piece of hyaline quartz that no doubt came from the

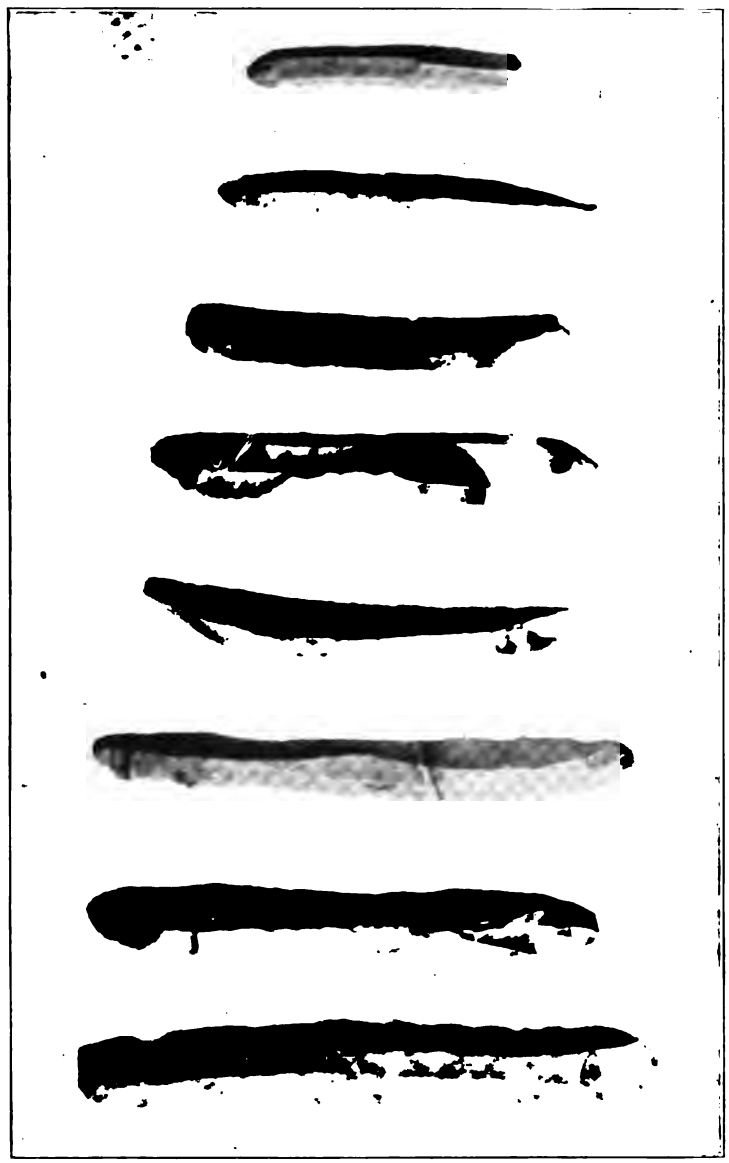

Fig. 21. Flaked knives found so abundantly in the workshops.

region of the blacksmith shop. From time to time the old village sites have shown the use of rock crystal in making arrow-points, and objects of rock crystal have been found in many of the mounds of the Hopewell culture. A large piece of rock crystal weighing between three and four pounds was found in the Paint Creek Valley and is now on exhibition in the museum. Mr. John Wilson found on his farm in Pickaway County a large piece of rock crystal weighing between twenty and thirty pounds, and it would not be surprising if in future years when the flint will likely be quarried for the silica, it will be conclusively shown that the home of the rock crystal found throughout Ohio is at Flint Ridge.

DISTRIBUTION.

The wide distribution over Ohio of objects made of flint is quite apparent to the student of archæology who has collected artifacts from the ancient villages, and naturally the distribution of the flint over the state would be attended with problems of interest as to the sources of the raw material. The raw material from any of the quarries in the state where flakable flint was obtained might be transported a long distance if made into convenient form. The distribution of flint from the great Flint Ridge quarries was doubtless on a large scale through barter or exchange, or by bands of aborigines coming to the quarries to secure the raw material for their own use. In this case the flint was made into blades or cores and carried away to be specialized, finished and used.

In a number of old village sites caches of flint blades, still retaining the crude edges and points just as they came from the roughing-out shops at the quarries, have been found. These caches are of great interest as they represent the storage places of surplus supplies to be drawn upon as required.

The exploration of mounds often reveals quantities of blades placed with the dead, perhaps the personal property of the deceased. The blades are not always found in caches as many occur in the village site, and frequently upon the surface, miles distant from a village site.

MANNER OF DISTRIBUTION.

Flint Ridge at an early date could only be reached by trails, and here the trails would end. The largest stream near enough for the use of boats was the Licking River, six miles north from the principal quarries. In Muskingum County the Licking River was only a few miles away, and the Muskingum River less than six miles distant and doubtless these streams were used to transport the blades and cores to eastern Ohio, north and south, and perhaps the Licking River furnished a route to the west as far as Newark and vicinity when the water was of sufficient volume to permit the use of small boats. Directly to the south, west and north the flint was carried long distances over trails in these directions. Practically all the objects made of flint found upon the surface in central Ohio came from Flint Ridge and practically all of the raw material was carried over the trails to the old villages and there specialized into arrow and spear-points, knives, scrapers, saws and drills.

RESUME.

A brief resume of quarrying the raw material from which such a large number of implements were manufactured will be of special interest and the following outstanding features, it is believed, will add materially to the fund of information concerning the quarrying of the flint at Flint Ridge.

The flint was quarried by the use of stone mauls and hammers (none of which were hafted) together with wedges made of wood or horn (although no wedges of any kind were found) and pries made of wood.

No evidence showing the use of fire in quarrying was found in the thirty-three quarry-sites examined and I firmly believe fire was not used as an agent in quarrying the flint, directly or indirectly, as some evidence would have been found in this great number of quarry-sites.

The flint was removed from the quarry sometimes only a short distance away, where it was blocked out and then taken to the workshops, usually in close proximity, where the blocked-

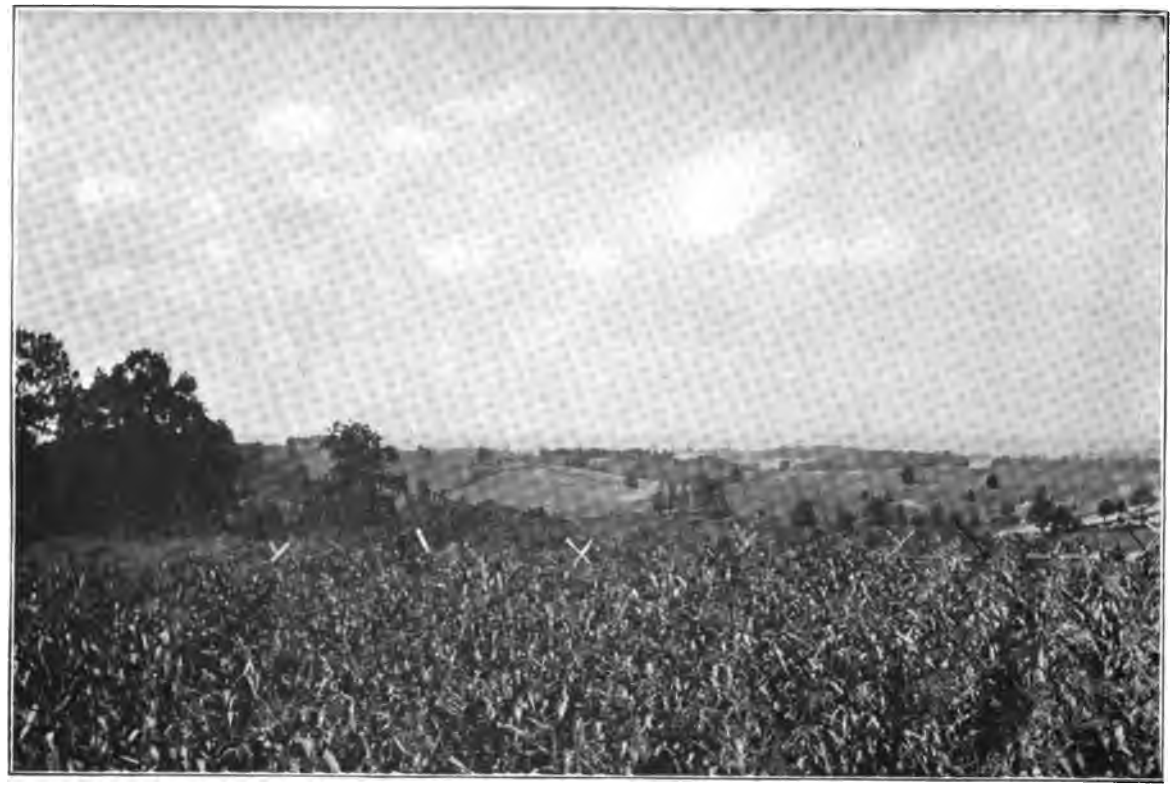

FIG. 22. General view of the country from the top of the Hazlett Mound looking northwest.

out pieces were made into blades or cores, the two principal commodities manufactured at the quarries.

It is very fortunate for those who wish to verify or disprove the statements made in this study of Flint Ridge that the full range of quarrying is still well within the reach of all investigators and needs only to be properly examined to reveal the facts.

The most striking thing that presented itself was that a primitive people with such crude implements showed such skill and perseverance in quarrying the flint from its bed and then displayed such versatility in fashioning the raw material into blades and cores ready to transport by man-power to practically every portion of the state.

THE QUESTION OF OWNERSHIP OF THE FLINT RIDGE QUARRIES.

Were the quarry sites owned by individual cultures or were the quarries common property among the tribes? In the region of the blacksmith shop at the cross-roads, where the flint was quarried, and in the region of Boyer's in Muskingum County, there is nothing to indicate that the sites of these quarries were guarded by certain tribes or cultures. Had the quarries been defended against an attack, we surely would have some evidence of attack in the way of lost arrow-points and other stone articles of warfare; on the contrary, specimens of arrow and spear-points are but seldom found. Only one place upon the "Ridge" shows a more or less permanent abode, the site being on the western end of the ridge, one and a half miles west of the blacksmith shop. Here, on the farm of William Hazlett, is a mound surrounded by a wall made up of blocks of flint. This mound we examined to ascertain the culture responsible for its construction.

THE HAZLETT MOUND.

The Hazlett mound is located on the farm of William Hazlett, situated in the western edge of Hopewell Township, Licking County, and approximately one and one-half miles west of the blacksmith shop. Near the site of the mound the flint ledge outcrops in very large boulder-like pieces of flint. During the

early settlement of Ohio the people made use of large pieces in the manufacture of buhrs for grinding grain. Large quantities of small pieces of flint, the result of forming the buhr-stones, are scattered over the ground in great profusion as are also partly finished buhrs. Broken pieces of flint of large size are found scattered over this part of the ridge in great profusion and these pieces were used in the mound and also to aid in constructing a wall of stone surrounding the mound. The dimensions of the mound before work was begun were: north and south diameter, eighty-five feet; east and west diameter, ninety feet; height thirteen feet three inches, and the general shape that of a flattened cone. The mound was covered with a dense growth of underbrush which was removed and burned. A photograph of the mound is shown in Fig. 23. The depression shown in the top of the mound filled with limbs and underbrush is the excavation of a former explorer. The work of examining the mound was begun on the east side, as shown in the photograph, Fig. 23, where the workman's head appears above the corn.

COMPOSITION OF THE MOUND.

The mound was made of earth gathered from the surrounding surface, and perfectly devoid of pieces of rock which would naturally occur upon the surface, except in a number of instances where small pockets of flint knives or scrapers or even select pieces of flint were placed. The soil was very loose and the examination was conducted with dispatch.

A HOUSE OF FLINT.

It was discovered after the work had progressed to the point of finding a long wall of flat blocks, and subsequently of four such walls, that the mound covered the remains of a flint house, the inside measurement of which was practically sixteen feet by sixteen feet eight inches, and the outside measurements thirty-seven feet by thirty-seven feet six inches.

The walls on the inside of the building were perpendicular and averaged six feet in height, gradually sloping to the ground on the outside and on the inside forming a right angle with a

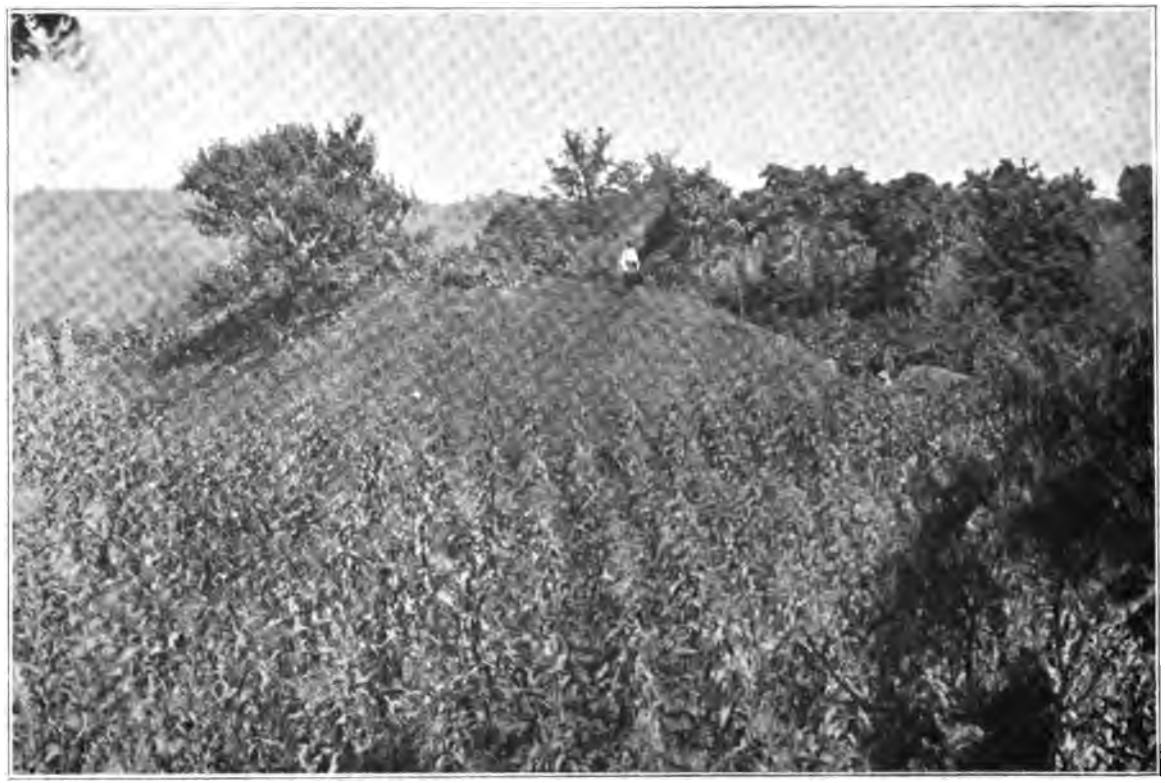

FIG. 23. View of Hazlett Mound after it was cleared of the underbrush and ready for examination.

base of practically ten feet. On the inside of the building upon the floor were found two skeletons, one placed near the south wall, which was undisturbed, and one near the northwest corner that had been disturbed by a former explorer who was satisfied with the artifacts found with the burial, and left the greater part of the skeleton in a pile at one side of the trench.

DETAILED ACCOUNT OF THE STONE STRUCTURE.

The space covered by the mound outside of the stone structure containing nothing of interest, only two small post holes being found, lying directly west of the structure but apparently having no connection therewith. The examination was begun on the east side of the mound and the beginning of the wall was struck just twenty-four feet from the starting point. This wall measured thirty-four feet in length, and is shown in Fig. 24. The blocks of flint used in constructing this wall were all small, only a few exceeding a cubic foot in size. These larger blocks are shown in Fig. 24, at the distant end of the cut and placed on the floor; they required two men to handle. The wall for the most part was made of small blocks of flint promiscuously placed on the outside, but so laid on the inside as to form a perpendicular wall six feet high, laid up without mortar. At the southeast corner a doorway was formed by the same manner of laying the stone. The doorway was one foot and ten inches on the bottom and about two feet at the top. Fig. 25 shows the doorway in this building also the south side wall and the angular turn in the wall forming the room. This cut does not show the full wall to advantage, as a slide caused by the heavy rains upon the freshly removed earth covered the greater portion of the wall exposed to the base, and it was found that the removal of wet freshly turned earth was not feasible, if not almost impossible, at the time; but cut No. 25 shows very well the outline of the walls of the building. The inside measurements of the room after the earth was entirely removed were sixteen feet east and west, as shown in Fig. 25, and sixteen feet eight inches north and south. The broken flint shown in the main body of the mound in Fig. 25 was taken from the wall

FIG. 24. Large blocks of flint forming the east wall of the stone enclosure covered by the mound.

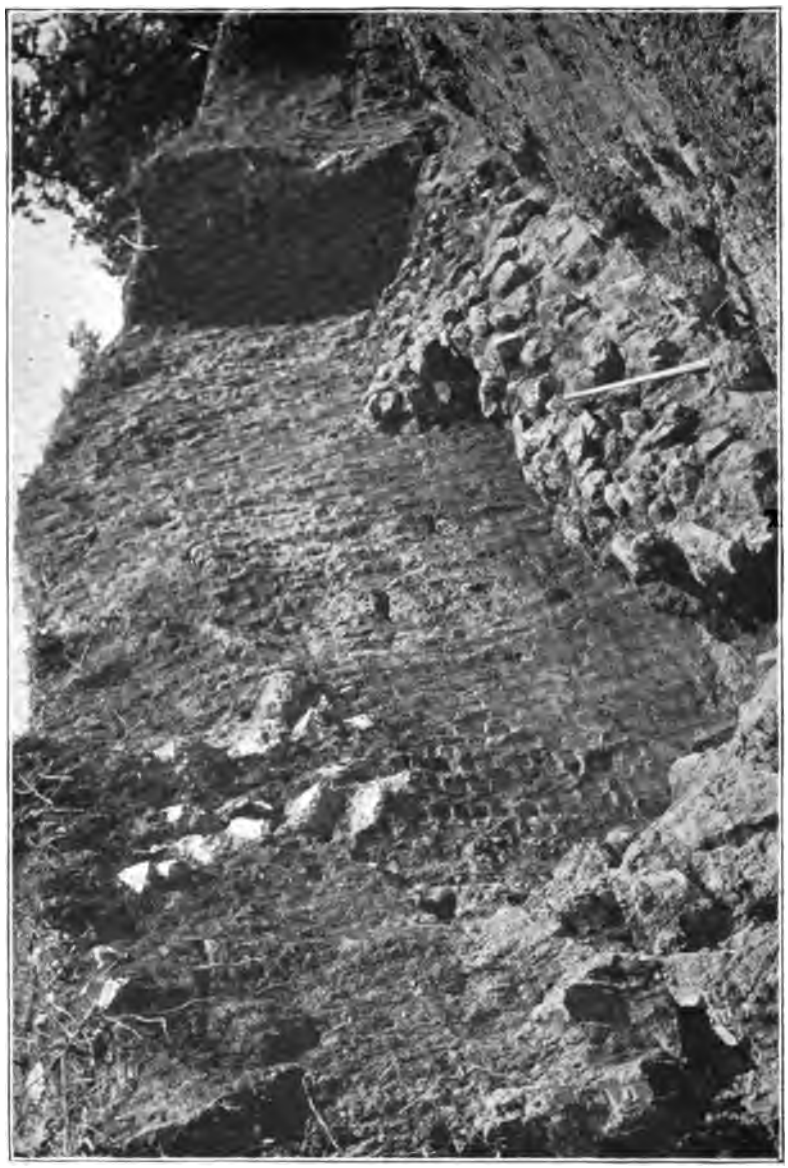

FIG. 25. Shows entrance to the stone structure.

of the building on the opposite side by a former explorer, and then thrown back when the excavation was filled. The soil was removed from the room, leaving it exposed as it appeared when the burials were placed on the floor and prior to heaping the mound over the building. The burials are shown in Fig. 26. The perfect skeleton placed along the west wall had not been disturbed by former explorers and was removed in very good condition. Fig. 27 shows the skeleton as it was uncovered. The body had been placed upon a prepared floor and under the head lay a large copper gorget of unusual size, made in the form of a conventional cross. The size of the gorget is eight inches long by six inches wide, and is considered as belonging to the Hopewell Culture. One of the fingers of the gorget may be seen extending from beneath the skull. An ear ornament of copper lies near the right cheek bone and another similarly located on the other side is not visible in the cut. Around the neck was a string of beads made of shell and on the right arm an object made of wood, covered with copper. In the left hand was an ornament made of the anterior half of the lower jaw of a gray wolf.

The part of a skeleton shown near the north wall of the structure had been disturbed by former explorers, who cut a trench six feet wide into the mound from the northeast, and when they came to the center carried the shaft to the base of the mound, where the great central fireplace was located, practically in the center of the room. The fireplace certainly was in use a very long time as indicated by the burned earth. However, nothing definite could be obtained as to its size, as the charred wood and ashes were thoroughly mixed with the earth. I am inclined to believe the parts of the skeleton found near the north wall were left in the place where it was found and the skull and a few other parts removed. No artifacts were left with the skeleton but it is generally understood that a number of objects were found.

The house was evidently supplied with a roof, as post-holes were found at the corners, as shown in Fig. 28. At the far corner in the cut, a stake about four feet high is placed in the

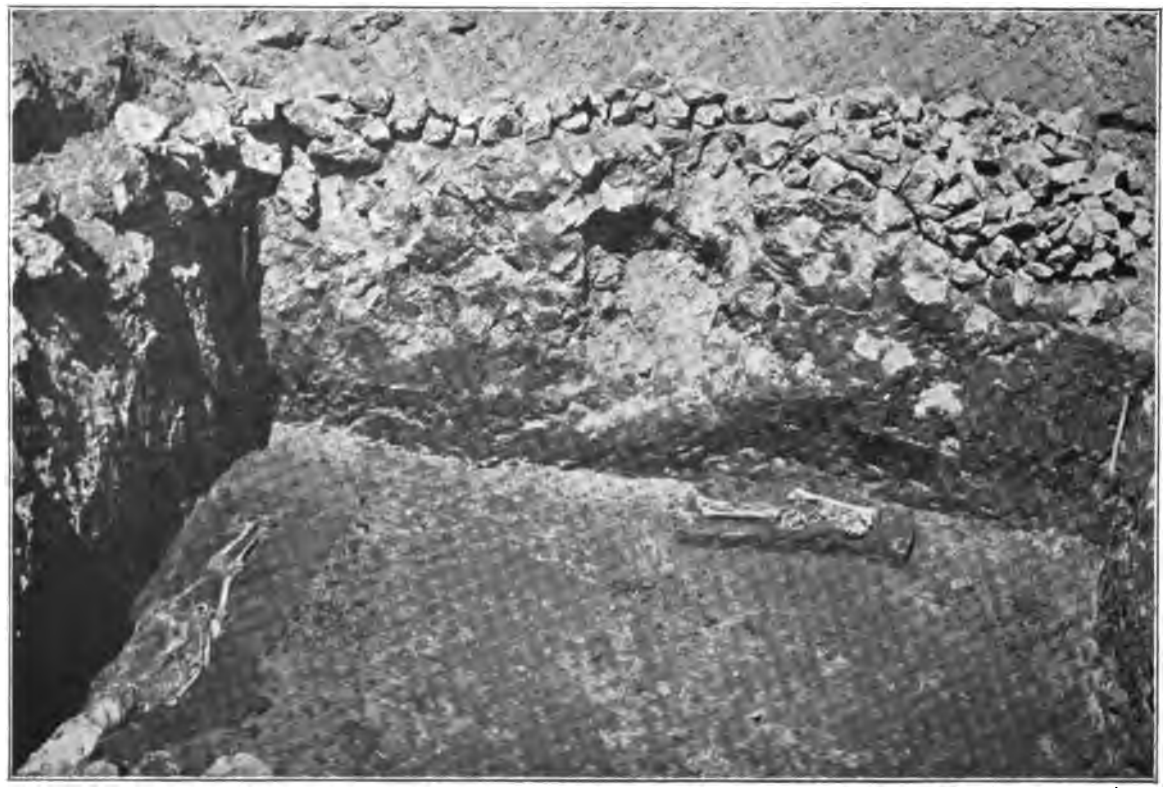

FIG. 26. Shows burials found on the floor inside of the stone structure.

FIG. 27. Shows skeleton with its ornaments of copper.

FIG. 28. View of the structure showing three sides.

post mold. At other places in the room post molds were found and no doubt served as supports for the roof.

DESCRIPTION OF ARTIFACTS FOUND WITH THE BURIAL.

The copper gorget is of unusual weight and size, being eight inches in length and six inches in width. The gorget was covered with a woven fabric, part of which still clings to the copper. The gorget is shown in Fig. 30. This type of gorget has been attributed to the Hopewell culture in Ohio. A number of these specimens made of both copper and stone were taken from the Tremper Mound in Scioto County and several were found in the Fort Ancient find of copper objects, all of which are on exhibition in the museum of the Society. The gorget was found directly under the skull of the skeleton.

The ear ornaments shown in Fig. 31 are of special interest as they are made a little different from the usual type found in the Hopewell culture, consisting of two similar concavo-convex plates connected by central cylindrical columns. Those shown in Fig. 31 were made similar to the majority of the ear ornaments of the Hopewell culture with the exception that one concavo-convex plate was replaced by a round and flat plate and smaller in diameter by half an inch.

The concavo-convex ear ornament is perhaps the most common ornament made of copper used by primitive man, and no doubt required great skill to manufacture.

WOVEN FABRIC.

The example of woven fabric shown in Fig. 31 was preserved by the salts of copper. A coarse cloth had been placed over a matting on the floor of the grave. The matting was made of bark, very coarsely woven, while only a few pieces of the cloth were preserved sufficiently to photograph.

The wood handle covered with copper, as shown in Fig. 31, is also of interest. The blade was apparently made of wood and was a continuation of the handle, which was preserved by copper.

FIG. 29. Carefully uncovering a skeleton on the west side.

FIG. 30. Copper gorget eight inches in length and six inches in width.

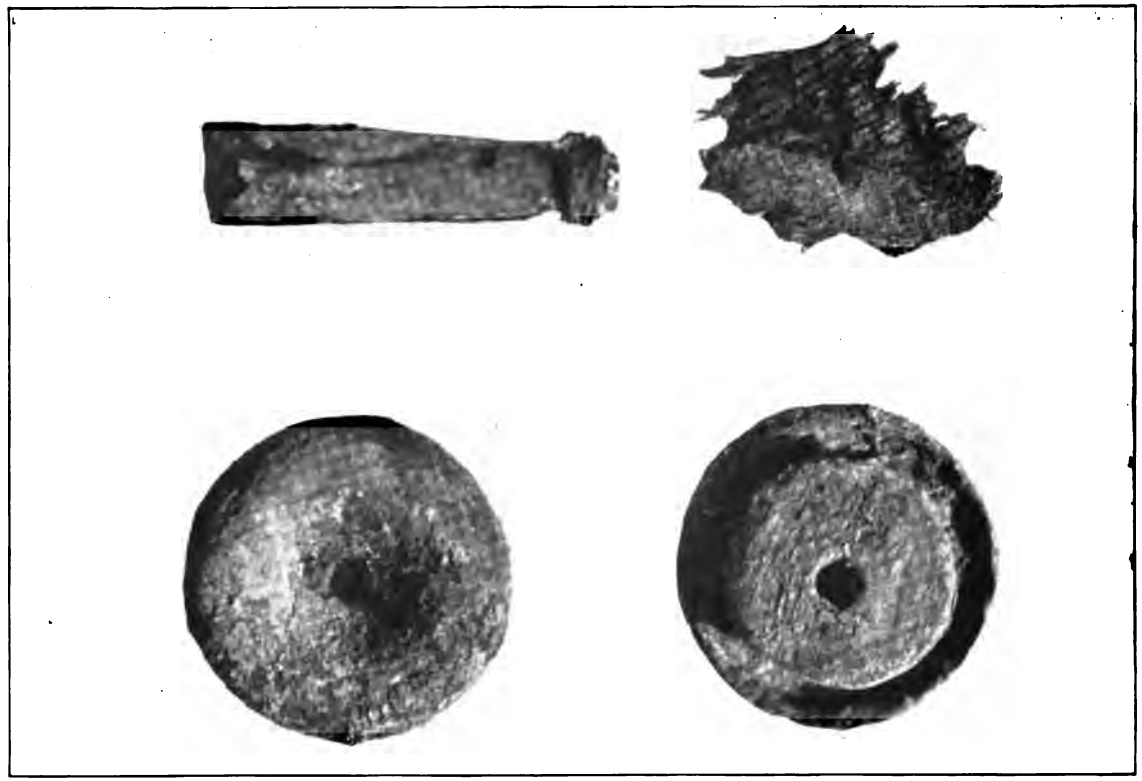

FIG. 31. Ear ornaments of copper; also a wood handle covered with copper and a woven fabric preserved by the salts of copper.

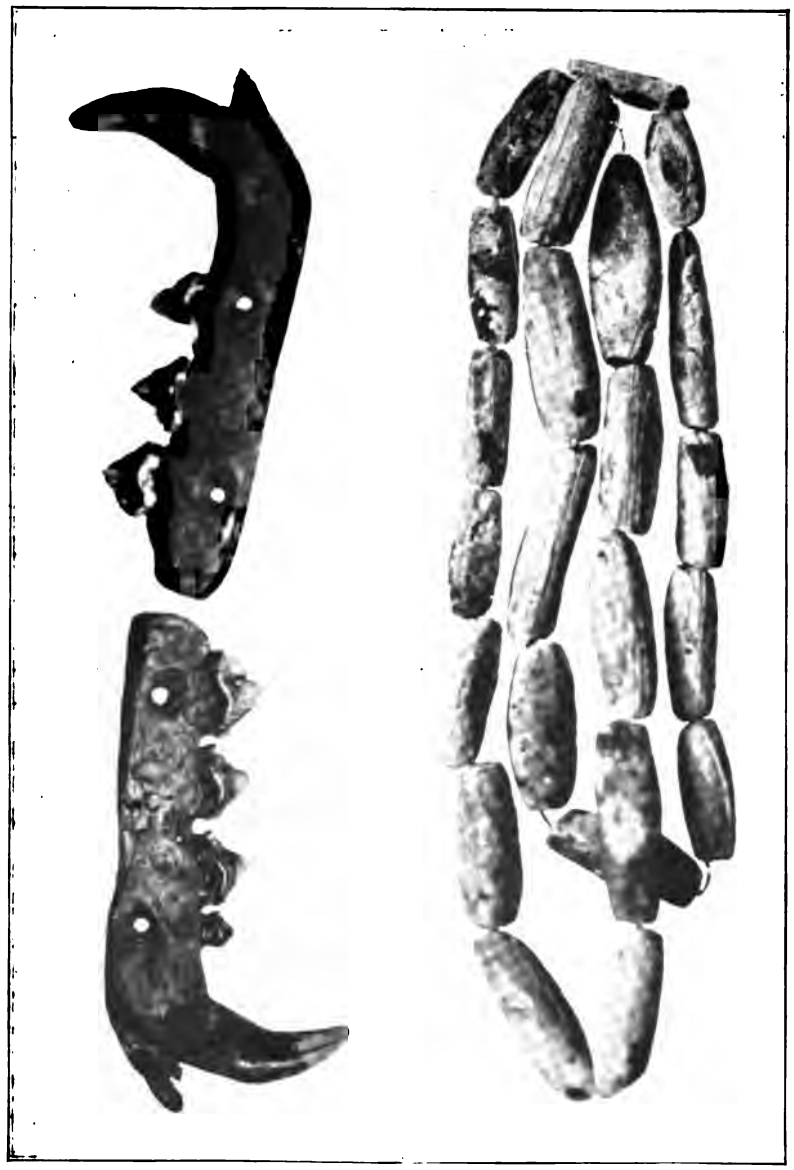

FIG. 32. Necklace made of ocean shells; also ornaments made of the lower jaw of the gray wolf.

The other ornaments found in the grave were a necklace of shell beads made from the columella of some ocean shell, and numbered twenty-three well made beads. The necklace is shown in Fig. 32.

In the left hand of the skeleton was placed an ornament made of the anterior part of the lower jaw of the gray wolf. The cut jaw is shown in Fig. 32. When in use as an ornament no doubt the two halves of the jaw were together.

RESUME.

The examination of the Hazlett Mound has established the fact that the Hopewell culture in Ohio constructed the mound, and proves beyond doubt that this culture resorted to Flint Ridge for the raw material for the manufacture of many of their artifacts and further that they had established themselves upon the ridge and in close proximity to the good flint quarries. No evidence is forthcoming as to the length of time the site was used. It may have been the refuge of the Hopewell culture from time to time as they would come to the Ridge for their supplies of the raw material. I fully expected to find some evidence that this building covered by the mound was used as a storehouse for blades and cores, for here a formidable defense could have been staged, behind stone walls of unusual size and height, against great odds if it became necessary to do so.

I do not feel that this fortified site, one and one-half miles from the great central quarries, was intended to guard any part of the quarries. I do feel certain, however, that such a fortified place so near to the source of supply served to guard the raw material after it had been manufactured into blades and cores, but no evidence that it was used for this purpose was found.